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TENTH ANNUAL REPORT

OF THE

NORTH DAKOTA

Agricultural Experiment Station

AGRICULTURAL COLLEGE, N. D.

TO THE

GOVERNOR OF NORTH DAKOTA

FEBRUARY 1, 1900

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Herman Croft . . . . Herdsman
J. Jessen . . . . Assistant Herdsman
R. A. Shattuck . . . . Secretary

LETTER OF TRANSMISSAL.

FARGO, N. D., February 1, 1900.

To His Excellency Governor F. B. Fancher,
Governor of the State of North Dakota:

Sir: As required by Act of Congress, approved March 2nd, 1887, and section 13, chapter 160 of the Laws of 1896, for North Dakota, I hereby submit the Tenth Annual Report of the North Dakota Agricultural Experiment Station for the year ending February 1st, 1900, together with a financial statement of receipts and disbursements, as required by law, for the government fiscal year ending June 30th, 1899.

Very respectfully yours,
W. H. ROBINSON,
President Board of Trustees.

REPORT.

To the Board of Trustees of the North Dakota Agricultural College and Experiment Station:

Gentlemen: I have the honor to submit to you the Tenth Annual Report of the North Dakota Agricultural Experiment Station. The past season has been favorable for experimental work and the several departments have made good progress and collected much data that will prove valuable to the agricultural interests of the state.

Eight Bulletins were published during the past year:

No. 35 by Professor E. F. Ladd—Some Chemical Problems Investigated.

1. A Case of Poisoning.
2. Soil Studies and Humus.
3. A Glucoside of Millet.
4. Sugar Beet Experiments.
5. Nitragin Experiments.
6. Florida Velvet Beans.
7. Preserving Eggs.

No. 36 by A. M. Ten Eyck, assistant Agriculturist—A Study of the Root Systems of Wheat, Oats, Flax, Corn, Potatoes, and Sugar Beets, and of the Soil in Which They Grew.

No. 37 by Professor H. L. Bolley—The Prevention of Smuts of Cereal Grains, and Prevention of Potato Scab.

No. 38 by Professor J. H. Shepperd, and Assistant A. M. Ten Eyck—Cultivation Experiment with Wheat and a Special Study of the Moisture and Temperature of the Soil Under the Campbell and Ordinary Treatments.

No. 39 by Professor J. H. Shepperd, and Assistant A. M. Ten Eyck—Variety Tests; Thickness and Depth of Planting Grain, Forage and Root Crops, Changing Seed Wheat, Rotation of Crops.

No. 40 by Professor J. H. Shepperd—Grasses and Forage Crops.

No. 41 by Professor C. B. Waldron—Some Hints on Ornamental Planting.

No 42 by Professor C. B. Waldron—Field Notes of Horticultural Department.

A combination sheep and pig frame barn, 36 by 48 feet, one and one-half story, was completed during the summer of 1899. This barn also provides a suitable room for classes in stock judging.

The poultry yards have been greatly enlarged and otherwise improved, and the barn, implement shed, poultry house, farm house, and dairy building have been newly painted. The main stock barn

was raised in the center and substantial pillars placed underneath. This was made necessary on account of the soft foundation and consequent sinking of the building.

Over twelve hundred farmers living along the line of the Great Northern railroad and its branches availed themselves of the generous conditions offered by its president, Mr. James J. Hill, and visited the Experiment Station during the months of June and July.

In addition to their duties as experimenters, the members of the Station Staff are required to do a considerable share of the teaching, especially during the winter term, when large classes of young men are formed for instruction in almost every branch of Agricultural Science.

Farmers' institutes have been held at Lidgerwood, Dwight, Gardner, Larimore, Lakota, Blanchard, Enderlin, Park River, Fingal, Wimbledon, Carrington, Harvey, Minnewaukan and Leeds.

At many of the above named places permanent organizations were effected for future regular meetings to discuss subjects affecting agriculture and animal husbandry. A large number of institutes are scheduled for February and March, and some later in the season. The demand for institutes is beyond our ability to fill. With the present over-crowded condition of the school, the Station Staff is required to work over time, without taking into account the institute work.

The state should make ampler provision for farmers' institutes. Farmers are entitled to some recognition, for money expended thus brings back to the state positive returns. Our soil is our pride and our hope, and to till it well and scientifically means great and continuous wealth; to till it otherwise must result in soil exhaustion within a few years, or at most within a few decades. The decreasing average yield of wheat per acre is already marked. The state cannot long overlook a matter so important as the foundation of our future greatness and prosperity. It is as marked an evidence of patriotism to preserve our soil as to preserve our institutions of liberty, and future generations will so consider it.

CHEMICAL DEPARTMENT.

To J. H. Worst, Director:

Sir: In submitting my Tenth Annual Report, for the year 1899, I present only a synopsis of the department work along certain lines, leaving the material for publication in bulletin form.

During the past year one bulletin was prepared and published by the Chemical Department, consisting of 26 pages treating of the following matters:

1. A Case of Poisoning.
2. Soil Studies and Humus.
3. A Glucoside of Millet.
4. Sugar Beet Experiments (in 1898).
5. Nitragin Experiments.
6. The Flordia Velvet Bean.
7. Preserving Eggs by Means of Water Glass.

Readers who may be interested in any of these questions are referred to Bulletin No. 35.

The work of the Chemical Department is greatly handicapped for want of proper room in which to conduct lines of investigations where time or the control of conditions, as temperature, etc., are factors. Our laboratory is too small for the required college work and there is not a single room that can be set aside for station work. At the earliest possible time additional room should be furnished and the station laboratory should be separate from all lines of student work.

The amount of routine work for the past year has been exceptionally large, and has consisted of analysis of waters for farmers, identification of specimens, minerals, clays, coals, ashes, etc. So great has been the demand that pretty nearly all of the time of one person has been given to this line of work. Several samples of milk and many food products have been examined, also samples of formaldehyde to determine the strength for use by farmers in treating wheat for destroying smut spores.

Much of the analytical work has been conducted by my assistant, Mr. Hugh McGuigan, who has faithfully performed his part of the work.

FOOD PRODUCTS EXAMINED.

Several food products have been analyzed, the results of which may be of general interest, and are presented in the following table:

Number		Water	Ash	Fat	Albumenoids or proteids	Crude Fiber	Nitrogen free extract
1	Wheat Grits	8.15	0.72	1.39	12.07	0.63	77.04
2	Cream of Wheat	4.77	0.43	1.29	11.37	1.46	80.68
3	Scotch Fife Wheat	9.33	1.88	2.83	13.62	3.48	68.85
4	Blue Stem Wheat	9.26	1.97	2.71	14.06	3.41	68.59
5	Flax Bolls	10.41	4.29	3 45	0.40	42.03	29.42
6	Spelt (Seed)	10.03	1.85	2.80	11.69	2.94	70.69
7	Spelt (Husk)	4.62	13.58	1.64	2.81	36 68	40.67
8	Wheat Flour	8.11	0.39	1.18	14.62	0.25	75.45

No. 1 is a breakfast food called "Golden Heart Wheat Grits," made in Moorhead, Minn.

No. 2 is a sample of breakfast foods put up in Minneapolis.

No. 3. Sample of Scotch Fife wheat from the Mandan Flour Mill, grown on new breaking and yielding 23 bushels per acre.

No. 4. Sample of Blue Stem wheat from same source, grown on old field, yielding 16 bushels per acre.

No. 5. A sample of flax bolls or hulls from the fibre mills at Fargo.

No. 6. A sample of spelt seed grown on College farm free from hull or husk.

No. 7. Spelt husks removed from seed No. 6.

No. 8. A sample of wheat flour from the Jamestown Flour Mills.

Three samples of beef were analyzed. No. 1, sample of porterhouse steak from a three year old steer. No. 2, sample of leg roast from same animal. No. 3, sample of leg roast like last but taken from a seven year old cow. The analysis presented are for the meats after roasting.

	2	3	1
	3 Years Old.	7 Years Old.	Porterhouse 3 Years Old.
Water	48.04	50.61	46.35
Ash	1.04	1.03	1.00
Albumenoids	24.00	22.38	20.28
Fat	24.83	23.16	30.57
Extractives, etc.	2.09	2.82	1.80
	100.00	100.00	100.00

Artificial digestion experiments were made, using pepsin for testing the relative digestibility of these meats.

	Percent Digested of the Cooked Meats at the End of 1½ Hours.	3 Hours.	18 Hours.
Porterhouse	89.10	90.60	95.50
3 Year Old	88.70	91.20	94.70
7 Year Old	86.90	90.00	94.80

Artificial digestion experiments were also made upon the fresh

uncooked samples with results as follows for amounts digested at end of:

	3 Hours.	6 Hours.	18 Hours.
Porterhouse	95.4	94.8	96.3
3 Year Old	91.7	93.8	95.2
7 Years Old	91.6	93.2	95.2

MISCELLANEOUS ANALYSIS.

Several coals have been examined, and since the western part of the state is so largely underlaid with lignites and the principal source of fuel for its farmers and for many industries, the following analysis will be interesting, as showing the composition of the product from one of the mines, air dried:

	Per cent.
Water	13 29
Volatile Carbon	38.09
Fixed Carbon	46.00
Ash	2.62
	100.00

We have also been frequently asked regarding the composition of the ashes from lignite, and the following shows the composition of a sample of such ashes sent in from Mandan.

	Per cent.
Insoluble matter, Si 0 2	29.54
Sulfuric acid, S 0 3	1.16
Magnesia, Mg 0	trace
Lime, C a 0	16.24
Iron Fe, 2 0 3 Alumina, Al 2 0 3	26.52
Potash, K 2 0 Soda, Na 2 0	23.44
Carbon, unconsumed	4.44
Carbonates and undetermined	8.66
	100.00

SOIL INVESTIGATION.

The work in soil analysis has been continued during the past year and many new lines of work in the humus problem undertaken and much interesting data secured to be published as a bulletin at a later date.

CLAY DEPOSITS.

A large number of clays and other similar deposits have been examined for parties in different parts of the state, and some of the results of analysis are presented in the accompanying table:

	1	2	3	4	5	6	7	8	9
Insoluble *matter Si o 2*	12.72	25.43	70.00	52.22	58.88	58.60	71.10	79.55	16.35
Alumina, Al 2 0 3	5.27	10.72	17.19	18.26	15.40	22 97	12.88	14.26	6.12
Iron Fe, 2 0 3	2.51	3.60	3.47	8.70	5.60	1.12	2.62	0.84	1.68
Lime, Ca 0	40.75	28.39	0.90	trace	trace	trace	trace	trace	24.30
Magnesia, Mg 0	1.62	1.23	0.85	trace	trace	trace	trace	trace	0.48
Sulfuric acid, S 0 3	3.15	3.90	3.07	0.52	0.68	0.50	0.29	?	15.92
Potash, K 2 0	----	----	----	2.40	2.40	0.66	1.26	0.61	----
Soda, Na 2 0	----	----	----	----	----	----	----	trace	----
volatile matter	34.64	26.16	5.00	18.78	17.66	15.62	12.95	4.54	35.79
	100.66	99.43	100.48	100.88	100.62	99.77	101.10	99.80	100.64

No. 1. Sample sent by B. G. Skulason, Grand Forks, and said to be from the Pembina Mountains.
No. 2. From same source, but somewhat different specimen.
No. 3. Clay from near Langdon, North Dakota.
No. 4. Sample from G. B. Olgeirson, Gardar, N. D., from ravine 300 to 400 feet deep. Taken about 30 feet from bottom.
No. 5. Same source as last. A 20-foot vein.
No. 6. From same source as last, in six inch layers.
No. 7. Same source as last, but nearly black in color.
No. 8. Sample sent in from Hebron. Taken from outcrop on side of bluff about 17 feet in thickness for deposit exposed.
No. 9. A sample from Lisbon, North Dakota.

SUMMARY OF TEMPERATURE, RAINFALL AND SUNSHINE.

The following tables give the maxima, minima and mean temperature for each month, also the total rainfall by months and the hours of sunshine:

	Maximum	Minimum	Mean	Rainfall	Hours sunshine recorded	Hours sunshine possible	Percentage of possible am't
January	39	-26	----	0.29	87.3	261.0	32.3
February	50	-37	0.4	0.29	141.6	287.9	49 2
March	53	-17	8.0	1.58	206.9	368.9	61.6
April	81	-10	41.1	1.39	244.0	424.9	57.4
May	84	23	52.5	4.22	182.5	453.1	40.2
June	88	38	63.8	3.44	240.0	475.5	50 5
July	94	40	68.4	2.78	297.0	481.5	61.7
August	89	37	67.2	3.71	198.0	395.9	50.0
September	92	17	55.2	1.24	222.6	377.8	58.9
October	73	21	43.7	1.67	100.4	336.6	29.8
November	64	9	36.0	0.27	110 7	287.2	38.6
December	46	17	14.6	0.33	127.6	267.1	47.3
				21.21	2158.6	4516.4	47.8

The hours of actual sunshine is the amount recorded by means of the Friez Photographic Sunshine Recorder and contains no twilight correction. Of actual sunshine not recorded by this photographic method I estimate about 12 per cent to be added to the above figures. In summer there may be added two to four hours additional daylight before and after sunset.

The total rainfall for each of the several years since our record began is given below:

	1892	1893	1894	1895	1896	1897	1898	1899
Total rainfall	20.73	16.17	18.72	16.85	20.36	22 30	16.20	21.21

This gives a mean annual rainfall of 19.87 inches for the past eight years.

SUGAR BEET EXPERIMENTS.

During the past year this department, in co-operation with the Department of Agriculture at Washington, has continued the sugar

beet experiment. There was sent out seed to 295 farmers, only 89 of whom sent in samples of beets for analysis during the past fall. Of this number 82 samples were received in proper condition for analysis.

The following table gives the results of the analysis for the several samples examined.

Seriel Number	NAME.	ADDRESS.	Per cent. Sucrose	Co-efficient of Purity
7	Leffingwell, W. H.	Ludden	15.90	84
9	Cochran, W. L.	Wyndmere	14.64	92
12	Kinney, James M.	Wyndmere	13.42	84
14a	Hackney, Geo. D.	Valley City	10.28	73
14b	Hackney, Geo. D.	Valley City	13.44	79
18	Whelan, Thos. K.	St. Thomas	11.26	72
27	Wickstrom, P.	Lisbon	13.94	87
31	Wilmort, Emile	Montpelier	11.40	87
32	Blakely, J. C.	Hope	15.44	77
39	Hilbert Bernard	Bac	13.84	77
43	Eddy, E. C.	Fargo	10.72	52
45	Mitchell, Peter	New Rockford	11.44	72
47	Lapierre, Joseph	New Rockford	15.96	88
49	Shanahan, P. J.	New Rockford	14.60	86
50	Galepski, Frank	Ardoch	8.68	67
53	Bullis, H. E.	Maple	12.34	77
54	Comtemanche, H.	New Rockford	11.26	71
55	Conlin, Martin	Eckleson	13.84	62
56	Johnston, S. C.	McRae	12.60	84
63	Jolliff, R. O.	Rolla	12.88	80
64	Finnie, D.	Emerado	15.00	83
72	Stark, F. J.	Akra	13.80	85
74	Philips, Richard	Albertha	18.48	90
80	Todd, G. H.	Oakes	9.82	75
82	French, N. S.	Grand Rapids	11.44	81
83	Myren, P. P.	Hillsboro	14.64	77
84	Parker, R. A.	Bottineau	13.42	84
86	Salter, H.	Mapes	17.94	91
89	Pinkas, V. C.	Absaraka	15.44	85
91	Tracy, G. W.	Dale	12.24	80
92	Smyth, J. N.	Verona	12.88	80
93	McDonald, E. H.	Hamilton	10.44	74
95	Campbell, Bernard	Buchanan	10.24	69
104	Rainsberry, N.	Lakota	8.72	72
105	Kirby, N.	Buttzville	13.54	84
106	Watt, Wm.	Leonard	13.00	87
110	Brock, J. B.	Williamsport	12.08	75
112	Bourassa, A. N.	St. John	15.32	85
114	Brosins, Nic	Anton	10.24	73
116	Harrington, J.	Jamestown	14 00	65
117	Bales, O. L.	Dale	15.84	79
118	Hauser, J.	Winona	15.34	77
121	Tufts, D. E.	Sharon	12.42	77
123	Overmoen, J. J.	Hillsboro	16.90	85
124	McPherson, A.	Sterling	lost	
127	Lindblom, P.	Wyndmere	11.50	72
130	Hill, E. L.	Maddock	15.54	81
133	Stanlep, C. H.	Steele	13.46	90
141	Estinson, J. C.	Hickson	12.36	83
143	Jungintsch, A.	Page	13.92	92

CONTINUED.

Seriel Number	NAME.	ADDRESS.	Per cent. Sucrose	Co-efficient of Purity
144	Bovie, C. B.	Jamestown	15.62	87
145	Toay, Michal	Jamestown	12.34	77
147	Jasper Joseph	Woodhull	13.18	88
149	Coghlan, Jas.	St. John	10.82	72
166	Erickson, E. A.	Portland	10.36	74
168	Fleck, J.	Richardton	14.60	81
170	Wells, T. G.	Lisbon	13.06	76
173	Carpenter, S.	Barton	10.78	72
174	Nordvie, C.	Trysil	9.74	69
175	Craig, R. S.	New Rockford	14.96	83
183	(a) Olmsted, S. A.	Ludden	13.12	77
183	(b) Olmsted, S. A.	Ludden	15 64	94
184	Mathison O.	Trysil	13.94	82
190	Quinlin, J.	Cavalier	11.00	78
207	Powell, R. F.	Cando	7.70	64
209	Beaudouin, A.	St. John	16.40	86
210	Schneider, Wm.	Dazey	17.62	93
213	Jacob, P.	Hankinson	9.70	45
214	Farley, K. C.	Ashley	11.44	71
226	Bowser. W. H.	Perry	12.14	86
231	Taylor. L. B.	Fairmount	11.80	79
232	Kartner, H.	Forman	10 84	72
238	Lewis, Frank	Tiffany	12.82	75
246	Bietz, Gosslieb	Ostrem	13.26	67
249	Widmeyer, G.	Rolla	12.60	42
254	Johnson, C. S.	Lowell	12.20	81
260	Veum, K. J.	Hoople	17.62	89
264	Wesley, George	Fisher	15.38	77
267	Kine, Wm.	Fisher	13.72	55
268	Wesley, Jess	Fisher	13.04	76
273	Smith, Mrs. M. E.	Fisher	11.80	74
283	Mitchell, R.	Hample	9.40	75
284	Agricultural College	Fargo	8.72	73
285	Agricultural College	Fargo	11.20	75
286	Agricultural College	Fargo	12 44	88
287	Agricultural College	Fargo	9.94	71
288	Agricultural College	Fargo	11.40	76
289	Johnson, C.	Oakes	11.74	78
		Mean of all	12.90	78

The seed furnished by the Department of Agriculture was of three varieties, "Vilmorin's Improved White" (2378); the "Zehringen" (2379), and "Mangold" (2884).

The following table shows the average, maximum and minimum for each of these varieties and number of samples tested:

	Vilmorin's.	Zehringen.	Mangold.
Number Samples	11	12	64
Maximum	15.64 per cent.	15.90 per cent	17.94 per cent.
Minimum	11.50 per cent.	10.24 per cent.	7 70 per cent.
Mean	13.96 per cent.	12.55 per cent.	12.85 per cent.
Co-efficient of Purity	62	81	79

The year has been generally unfavorable and farmers in sending in their reports state quite generally that the season was not favorable for best results. Again, often the ground was not properly prepared nor the beets well cared for during the summer.

Respectfully submitted,

E. F. LADD,

Chemist.

DEPARTMENT OF BOTANY.

To Director J. H. Worst:

Sir: The station work which I have to report upon for the year ending December, 1899, may be summarized under about five general headings:

Studies Upon Cereals; Weed Studies; Selection of Potatoes; Bacterial Investigation and Microscopical Examinations; and Miscellaneous Work.

During the year the department had the assistance of Mr. Merton Field until the close of the month of July. Since September 1st, Mr. Lawrence Waldron has been assistant to the department in teaching and station work. About one-half of Mr. Waldron's time can be had for station assistance.

A.—STUDIES UPON WHEAT AND OTHER CEREALS.

I have considered that the cereal grains and grasses are the plants about which the people of this state have the greatest desire for information. I have therefore given most of my time, open to station work, to various studies and observations upon these plants.

STUDIES IN WHEAT SELECTIONS, OR RATHER OBSERVATIONS UPON THE GROWTH AND PRODUCTS OF WHEAT PLANTS OF KNOWN SELECTED PEDIGREE.

It has often occurred to me that it could be possible to demonstrate the prinçiples upon which rational wheat selection might be based. Present best practice calls for so screening seed wheat that the seed sample is reduced to an even quality of large heavy grains. There is, however, a difference of opinion as to what wheat grain is the best one to plant. Some farmers contend that a small hard grain is as good as a larger one. In fact, when the subject is thoroughly canvassed, the results of the canvass leave one confused as to the facts. Again many seedsmen have theories concerning the value of certain grains in the individual wheat head.

The probability of gaining any very definite information upon such questions, it seems, lies behind many years of patient observation yet when undertaken there are always side facts which come to light sufficient to pay for the effort. In 1895 I started a series of wheat grain selection. The work laid out may be summarized about as follows, using the following types of seed wheat.

a. { 12 smallest normal grains in one head.
12 largest normal grains in same head.

b. { 6 lowest normal grains in one head
6 highest or tip normal grains in same head.

c. { 6 grains from the outside rank of grains from four ranked heat.
6 grains from middle rank of grains from four ranked heat.

d. { All of the grains from a large mature head.
All of the grains from a small unmature head from the same stool.

These plantings were undertaken for a number of duplicate tests upon a very finely prepared soil, and the following records were taken in each case:

Before sowing—Form and color of the grains; and the total weight of the grains.

After gemination—Notes on growth, number stools, number straws, total weight of straw and grain, total number of grains in the largest head, and the total length of the largest best straw, were taken and the best head for the year was kept and photographed.

The spring of 1896 found the department so fully occupied with teaching and with other station work that it was impossible to carry on the work as planned. The recorded wheat heads were stored in the laboratory, unthreshed.

Last spring (1899) an examination found that the grains had retained viability so that it was yet perfect.

From these heads the work was again undertaken; but upon a much more limited plan. Plantings were made only from the six largest normal grains and from the six smallest normal grains of each head. In each case the small seeds averaged less than one-half the weight of the large ones.

Along with the test there was planted hand picked grain as follows: 1,600 smallest perfect grains, the total weight of which was 35 grammes, and 1,600 largest grains, the total weight of which was 50 grammes. The total product from the experiment was: From large seed, 20 pounds, 14 oz. of straw and grain; from small seed, 18 pounds, 2oz. of straw and grain. This gave a difference of two pounds 12 oz. in favor of the 1,600 large seeds.

The total results of the two years work are very interesting but must be studied in detail to be of value for comparison.

This line of work will now be continued from year to year, as it gives promise of affording valuable information. (Lab. Book 9, pp 66, 65, 93.)

THE WORK WITH THE SMUT OF CEREALS—CONDITIONS OF GROWTH.

Since 1895 effort has been made to ascertain the influence of different dates of seedings, soil conditions, climate, heredity, etc., upon the growth of smuts and rusts. The difficulty of attacking this question lies in the fact that every hour of the growing season introduces a different condition of soil and air. The tests conducted upon the smuts have given some good results, making it less difficult to explain some of the peculiarities of these diseases, their appearance and non-appearance in a crop from the same seed in the same season, etc.

In the case of stinking smut of wheat (*Tilletia*) the following general statements may be drawn from my observations. They may need future modification, but I think that, in the main they will be found to hold good. They have been formulated after a comparison of the results of tabulated daily observations upon the growth from daily plantings of smutted wheats—associated with daily observations upon the physical conditions of the air and soil; and after consideration of laboratory studies upon the smut plant and its host. The details are too extensive for this report: (1) *Tilletias* of wheat in this region grow well if left exposed to the weather in the unbroken "smut balls" throughout the winter months. (2) For best germination, normal spores demand that condition of soil atmosphere which approaches saturation. (3) The presence of actual water in the soil is detrimental to the infection of wheat. (4) The range of temperature for the germination of spores is wide when atmosphere moisture in the soil is right. (5) A low atmospheric humidity associated with a comparatively dry soil and a minimum temperature ranging higher than 40 degrees during the ten days following seeding seems unfavorable to the development of the disease in a wheat crop. (6) The same conditions as those last stated with a minimum temperature ranging from 15 to 35 degrees Fahr. during the period from five to ten days following the seeding time tends to give an increased infection. (7) The best soil conditions for a high percentage of infection in the field may be stated to be that one which will give a good growth of the wheat plant for about four days associated with a saturated soil atmosphere and a daily temperature showing a minimum of 15 to 35 degrees Fahr. during the next following four or five days, followed by a normal season's growth. The season of 1897 started out April 15th with the seed bed in very fine condition as to soil texture and moisture. The conditions became continually dryer until May 19th with but one or two intervening showers. The year was thus particularly a suitable one for those tests. The same sample of smutted seed wheat gave very different results upon different dates of seeding—at one time, 17.5 per cent. of smut, at other times, a less amount and for a time none of the samples of smutty seed wheat produced smut. (8) These variations were found to agree in a marked manner to certain variations in soil moisture and temperature. In the same tests smutted millet was seeded also. It was found to develop less extensively when the seed bed was comparatively dry for some days after the date of seeding. When the ground was too wet to produce a large growth of wheat smut (*Tilletia*), the growth of millet smut was the greatest. The range of smutting in the millet was 9.2 per cent. of smutted heads from the seeding date of May 14th to 30.7 per cent. of smutted heads from the seeding of June 14th. These two dates represent respectively the dryest and the wettest seed bed for the week following the germination period. (9) Thus it is probable that each species of the smuts will be found to give variations as to these matters of condition. There are indications also that weather con-

ditions throughout the growing season which influence the growth of the host plants also indirectly influence the development of the smut in the crop.

TESTS OF TREATMENT IN 1899.

(1) The Use of Formaldehyde Fumes for Grain Disinfection.—Following the tests of 1898 in which it was found that on a small scale fumigation of grain could be successfully accomplished with formaldehyde, I undertook to ascertain in the labatory the range of possible treatment. A small laboratory fumigator was constructed upon the plan of figure 1, p. 23. A number of tests were made upon wheat, oats and barley. A record was afterwards taken upon the effect upon germination, and finally the resulting growth of the seeds in the garden was observed. The following table shows chief points of interest, as to wheat:

Kind of Seed.	How Treated.	Germination Record.				Result in Crop.
		Strong	Medium ..	Weak	Total	
1.—Wheat ..	Fumigated 20 minutes	80	12	4	96	Fine crop, 10 per cent. smut.
2.—Wheat ..	Fumigated 30 minutes.	85	15	..	100	Heavy crop, 9 per cent. smut.
3.—Wheat ..	Fumigated 40 minutes	79	17	4	100	Heavy crop, 10 per cent smut.
4.—Wheat ..	Fumigated 50 minutes.	80	19	1	100	Good crop, trace of smut.
5.—Wheat ..	Fumigated 1 hour.	75	20	4	99	Trace of smut, weak first growth.
6.—Wheat ..	Fumigated 1½ hours.	74	14	7	95	1 per cent. stinking smut.
7.—Wheat ..	Fumigated 2 hours.	57	21	11	89	First growth weak, thin. Good crop. Stinking smut present.
8.—Wheat ..	Fumigated 12 hours.	00	26	18	44	Thin crop; no smut.
9.—Wheat ..	Untreated.	80	10	6	96	Good crop: 10 per cent. smut.
10 Fletcraft's Wheat ..	F'g'd 45 m by Formochloral.	..	15	5	20	Thin crop; 4 stools of stinking smut.
12.—Wheat .	Untreated.	..	10	80	90	Thin at first; 50 per cent stinking smut.
13.—Wheat .	Dipped in sol. of Formaldehyde 1 lb. to 45g.	3	82	8	93	Good first growth; no smut in crop.

There were many other of these small laboratory tests conducted upon different samples of smutted wheats with results about similar to those given in the foregoing table. The results of these laboratory tests did not give much hopes of success upon the field plan; but from them, much was learned of value as to the action of the fumes of formaldehyde upon seed grain. (1) It was observed that the smut spores still retained the power of germination long after much weak wheat was killed or much injured. (2) That in all probability the fumes are effective in killing smut spores chiefly because of the presence of moisture in connection with the spores. Hence the regular solution is most regular in action. It was also noticed that

weak or soft wheats were also very quickly injured by the application of the fumes, while dipping such wheats in the standard solution of formaldehyde for smut prevention improved the strength of the first growth. Compare numbers 10, 12 and 13 of the table.

In the work with barley and oats this was made much plainer. It was found that for these soft grains, which are very much more liable to decay at germination time than wheat, fumigation in the presence of steam greatly strengthened the first growth from the seed, there being a length of time for exposure which killed most fungi and bacteria of decay and left the grain so nicely disinfected that when placed in a clean germinator no decay or molding occurs while germination is not retarded. This result is well attained by the use of the liquid treatment. but I found it difficult to control in the practice of fumigation. (Note book No. 9, pp. 212-221.)

Treatment In the Field.—The fumigation experiments were given a thorough trial upon a field plan, and I think together with the foregoing laboratory tests practically settles the question of the practicability of the process for farm use. The accompanying figure 1 represents a section view of the apparatus used. A galvanized cylindrical tank was construced, as there represented, capable of

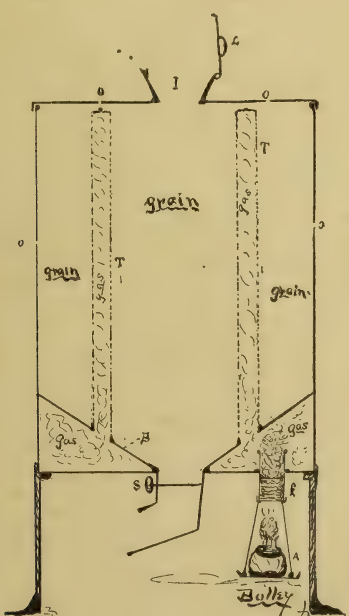


FIGURE I.

holding 15 bushels of grain. It possessed a second or inside bottom (b) perforated at eight points upon which stood $2\frac{1}{2}$-inch perforated tin tubes (T). Gas was gerated by evaporating liquid formaldhyde

(f) over a burner at (A). The gas entered the tank below the inside bottom, and there were furnished small openings for the escape of air and gas at the points marked (o) so that the entire body of grain was quickly permeated by the gas. This was speedily recognized as accomplished, for within a few minutes after our machine started it was found almost impossible to live in the immediate neighborhood. This would prevent the process from being of practical use on the farm, even were it otherwise a success. The cost of making a fumigation machine which would allow of ordinary methods of work, it seems, would be too great to be desirable. Lime water was added in small amount to the formaldehyde to prevent the formation of the Peri-formaldehyde when the liquid was boiled in an open vessel, or Formochloral was used which stands open boiling. Sheering's tablets were tested in the machine, also the Lentz generator. But for the purpose, the open evaporator served all purposes when lime was added to the evaporating liquid. No experiment gave a successful prevention of smut. The following tests will suffice to show the range of the work and the efficiency of dry fumigation with formaldehyde. The wheat used was made up of a mixture of three samples of very smutty wheat—furnished by Mr. Flitcraft, of Gardner, Mr. Hannan, of Mayville, and Professor Shepperd, of the College:

Exp. No. 1. Ten minutes fumigation in fumes from "Formochloral"—wheat grew normally. Crop showed 25 per cent. of smutted heads.

Exp. No. 2. Forty minutes fumigation as above—good growth from first—27 per cent. smutted heads.

Exp. No. 3. One hour and ten minutes fumigation—growth apparently as good as usual—31 per cent. smut.

Exp. No. 6. Two hours and ten minutes—Fumes from formaldehyde and lime water. The large barn room became unsuited for work. The grain came weak and thin. Actual smut showed 51 per cent. of smutted heads in the crop.

Exp. No. 8. Grain was placed in a sack and kept in a tight tank, fumigated twenty minutes by formaldehyde. Gas generated by Lentz apparatus. The steam from the machine was sufficient to moisten the grain considerably. Result : Slow, weak irregular growth. Wheat thin on the ground. Twenty-four per cent. of smutted heads in the crop.

Exp. No. 12. Same wheat dipped in the standard formalin solution, 45 gallons water, 1 pound of formaldehyde, for the preventing of smut. Heavy crop; no stinking smut.

Exp. No. 19. Same wheat untreated. Total amount of smutted heads in the crop was by actual count over a large area equal to 67 per cent.

The Chloride of Lime Treatment.—Many persons have advocated the use of chloride of lime for disinfecting seed grain. The method advocated by Mr. Huntoon, of Moorhead, was the addition of four pounds of chloride of lime to one hundred bushels of wheat—mixing

the same one month before seeding time. I have given the idea full trial. It has no merits, as is fully shown by the following tests, in which the same wheat was used as in Exp. No. 12, p. 22.

Exp. No. 9. March 25th placed wheat in a tight 52-gallon barrel. Used two pounds of chloride of lime (fresh) to two bushels of wheat. Kept barrel closed until April 27th, when wheat was seeded. Results: The germination record was as good as untreated seed and it also came up well in the field. The crops gave 44 per cent. of smutted heads.

Exp. No. 10. Same wheat; one pound of chloride of lime mixed with one peck of wheat, the whole boxed tight for one month and two days. Had difficulty in seeding this wheat, the lime had drawn much moisture from the air. It did not kill smut. The crop showed 57 per cent. of smutted heads of wheat.

A number of other treatments in which the lime was used in much less strengths but always of greater strengths than that recommended by Mr. Huntoon. All failed to lessen the amount of smut in the crop.

The Formaldehyde Treatment.—No treatment yet tested compares in cheapness of cost and success of prevention with the Formaldehyde "sprinkling and shoveling" method.

I give here the results of two practical farmers in determining the amount of the solution used in their work of treatment when done by the men at the farms. Mr. R. E. Fleming found after sprinkling and shoveling 1,800 pounds of wheat that the wheat then weighed 1,980 pounds. This reduced to figures shows that Mr. Flemming used at the rate of three-fourths gallons of solution per bushel of wheat. He raised a clean crop.

Mr. Geo. Osgood treated 2,090 bushels of wheat. Mr. Osgood "dipped in a large two handled flat bottomed box, handled by two men, and found that he used up 75 gallons of solution per one hundred bushels of wheat. Mr. Osgood's seed was "rejected" because of smut. He was able to offer one dollar per head for smutted wheat in the new crop. His men were unable to profit by his offer at harvest time. (Note Book No. 9, pp. 212-234.

THE RUSTING OF CEREALS.

Along with the weather studies upon the smutting of cereals the rust studies were considered. I have reached no further conclusions than those previously stated, i. e. that the most profitable studies upon rust will probably lie along the line of plant selection. (Book No. 9, pp. 445-260; also the work of 1898-1899 in field notes.)

THE DESTRUCTION OF WEEDS IN CEREAL GRAINS BY MEANS OF CHEMICAL SOLUTIONS SPRAYED UPON THE FOLIAGE.

During the spring of 1896 I undertook to kill weeds in grain by means of a spraying method. The results then attained discouraged further effort until the spring of 1899. During the spring, summer and autumn of this year 51 different spraying experiments have

been conducted, using several chemicals upon all the common weeds and cereals. The results have been most encouraging; and give promise that where weeds are too thick to pull they may be effctually eradicated without destroying the growing cereal crop. August 10th I made a preliminary report of the work to the Society for the Promotion of Agricultural Science—Columbus meeting, 1899. It is interesting to note that the work with Copper Sulphate has proved quite a marked success in the hands of several experimenters, working independently. In my own work with that substance I found one pound to four gallons of water and about 40 to 50 gallons per acre to give the best results. Other chemicals have been tried with marked success and give promise of much success. The detail of this work is too extensive for the purposes of this report and will be held until a full report may be made embracing recommendations as to methods. (Note Book No. 9, pp. 262.)

THE LIFE OF WEED SEEDS PLANTED AT DIFFERENT DEPTHS.

In this region of slight crop rotation it becomes a matter of much importance to determine the duration of the life of weed seeds in the soil when buried at known depths. The following test has been planned and started this autumn. The soil beds were prepared by removing a sod seven years standing, and placing the soil in fine garden condition. Seven kinds of seeds were planted, each in its own bed. In each bed six rows of seeds were planted, at depths of 1, 2, 3, 5, 7 and 10 inches respectively, beginning with the one inch seeding at the south end of the bed. The beds are so constructed as to be permanent, anc the seeds are so placed as to be in normal soil condition, yet so that a part of them may be taken up at any time without disturbing the remainder. Beginning with the south bed, the seed beds contain seeds of

Capsella bursa-pastoris (Shepherd's Purse).
Thlaspi arvense (Penny Cress or French Weed).
Setaria viridis (Pigeon Grass).
Ambrosia trifida (Greater Rag Weed).
Brassica sinapistrum (Common Wild Mustard).
Polygonum Convolvulus (Wild Buckwheat).
Avena fatua (Wild Oats), respectively.

The rows were seeded 12, 15, 21 and 24 inches apart, so as to allow growth and work in the rows without disturbing, the narrowest spaced rows on the south.

The seeds were not placed in the ground until October 21st, when it was thought they would remain ungerminated until spring. But we were deceived, a part of them continued to come up until November 25th. On that date *Thalaspi* showed twenty-five growths from the one inch planting.

Avena: $\left\{\begin{array}{l}\text{1 inch seeding, 27 plants.}\\ \text{2 inch seeding, 16 plants.}\\ \text{3 inch seeding, 6 plants.}\end{array}\right.$

Brassica: $\left\{\begin{array}{l}\text{At 1 inch seeding, 435 plants.}\\ \text{At 2 inch seeding, 300 plants.}\\ \text{At 3 inch seeding, 40 plants.}\end{array}\right.$

Elevator and Mill Studies.—It seemed important to have a clearer understanding of the relation of the milling and elevator interests to farming methods. To this end a number of mills were visited in the state and in Minnesota. Elevators were visited in practically every locality in the state. These studies gave much valuable information concerning the milling qualities of wheat, methods of handling, methods of milling, effects of smut, about weed seeds and weed distribution, wheat grading, etc. I wish here to thank the millers and elevator men for the uniform courtesies extended at all points.

As a general statement of the results of these visits it may be said (1) that stinking smut of wheat was found to be general in all the wheat growing communities of the state, and that the millers and elevator men are very anxious that the farmers should cease to grow it. I have found that by washing grain in distilled water, and then causing sedimentation of the water by means of a centrifuge, to be a very satisfactory means of detecting the presence of smut spores when present in such small quantities as to be otherwise impossible to detection. The amount of smut seems to vary in different regions, but I was unable to come to any general conclusion in this matter. (2) Elevator and mill men are quite uniform in their statements that the following weed seeds furnish the bulk of the screenings and dockage in the wheat of the state:

(1) "King Head" (*Ambrosia trifida*)—It also "cuts" grade because difficult to remove.

(2) Cockle, "rough," (*Lychnis Githago*)—It "cuts" grade.

(3) Cockle, "smooth," (*Saponaria Vaccaria*)—It "cuts" grade.

(4) Wild Buckwheat (*Ploygonum Convolvulus*).

(5) Pigeon Grass (*Setaria viridis* and *S. glanca*).

(6) Wild Oat (*Avena fatua*).

From my own experience, none of these weeds reduce the yield equal to the work of the pigeon grasses. Number three is at present the greatest menace, for it is a new weed in the farm work of the state, and is spreading rapidly. It is a great seed producing annual, the seeds of which take charge of the ground after the manner of common mustard, and is about as difficult to erradicate.

THE WILD OAT.

There are many varieties of awned oats in the state. Many tame oats are so hairy, barbed and awned that it is often difficult to determine whether wild or not from the seed. This season I observed the growth of twenty-seven tame varieties and also that of *Avena fatua*. I found that there are many tame oats of heavy yielding quality that in nearly all characters are wild in appearance. I found wild oats of size and weight which would compare favorably with most tame varieties. There was always one difference easily noticeable: *The wild oat grows an awn upon the secondary grain of the spikelet. No tame variety under observation bore an awn upon the secondary grain or flower.*

Studies were undertaken in crossing the wild and tame varieties, but I have nothing to report at this time.

B.—THE SELECTION OF POTATOES FOR SEED PURPOSES.

The work of testing the value of the large and the small potato from the same vine for seed purposes was continued for the sixth season, using five varieties of potatoes. The seed tubers were selected from last year's pedigreed crop. The results again affirm those of previous years. A mature bud from one vine thus appears to be as good as any other from same vine, when furnished with the same weight of tuber piece.

During the six seasons the continuous selection of a small potato from the same vine or strain, the work has not tended to "run out" the crop. The products from this sort of selection seems to have been each year neither better nor worse than those from the line of selection in which the biggest, best tuber was always taken. Soil and cultivation seems to be the main element in causing a variation in the standard of a potato strain. As there is always manifested a large element of variation in the different strains of a variety, the future work of the department upon the culture of the potato plant will be concerned in taking notes upon direct selection for improvement. The aim is not to get a good potato, but to learn by what means to proceed.

C.—BACTERIAL STUDIES.

One line of bacterial study was conducted throughout the year. The laboratory was also kept open for analysis of drinking waters, a number of which analysis were conducted. There have also been made a number of sputum analysis; and some microscopic examinations to determine the causes of diseases in farm animals.

The most important work of the year was the investigation undertaken in association with the Chemical Department upon the determination of the bacterial content of the soil. This work gave good results, but needs further investigation. (Note Book No. 10.)

One point of scientific interest was that involved in the question as to whether there are any bacteria, which may, as indicated by some investigators (Winogradsky and others), develop normally in a purely mineral food medium. The conclusions regarding this matter are recorded in a paper upon "The position of the fungi in the plant system as indicated by the work on the organisms of nitrification." (Centralblatt f. Bakt. Zweite. Abt. V Bd. No. 25.)

"The Duration of Bacterial Existence Under Trial Environments." —During nine years, the department has taken notes upon the vitality of various species of bacteria, when kept under known condiitions. The results of this work were presented before Section "G" of the American Association for the Advancement of Science, Columbus meeting, 1899. The paper has been printed in the Centralblatt fur Bakt. Zweit. Abt. VI Bd. No. 2. The most important features of the

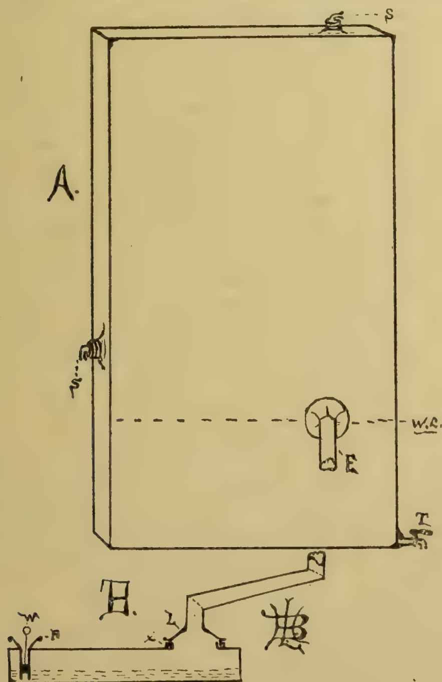
work, from a practical standpoint, is the fixing of the fact of the wonderfully lasting vitality of the Bacillus of typhoid fever.

D.—MISCELLANEOUS STUDIES.

Distilled Water for Drinking Purposes. — Though perhaps, not worse than the average quality of the water supply in many other localities in the great plains, it is certain that much sickness and ill health upon the farms is due to the water supply. In general the water supplies of the state have been found to be far too heavily laden with mineral matters, and often contaminated with germs of disease. Indeed, it may be said that from this latter cause alone the water of any surface supply is unsafe. It is now generally agreed among physicians that the use of distilled water for drinking purposes would save from much disease and ill health.

There is no cheap distilling apparatus on the market suited to use upon the kitchen stove, none which can produce sufficient distilled water for the use of a family. I have therefore undertaken to plan a distilling apparatus which any tinsmith can construct at small cost, and one which will provide a large amount of distilled water.

The following described apparatus can be constructed at a cost of five to ten dollars. Upon the ordinary kitchen stove it will furnish



FIGRUE 2.

from seven to twenty gallons of water per week, according to the constancy of the fire. One has been in use in my home one year and three months, and has furnished a constant supply of the pure water.

Directions for Construction.—The parts to be constructed are shown in figure 2, the condenser "A" and the evaporator "B." Make an inclosed evaporator pan, "B," large enough to cover two holes of a kitchen stove or range, say 21½ inches by 9¾ inches by 4 inches, for a No. 9 stove. It is inclosed at all points except only the filling funnel (F) and the steam escape tube (L). The funnel tube is three fourths inches in diameter, is soldered into the top of the pan, and reaches within one-eighth of an inch of the bottom—to prevent escape of steam. The steam tube (L) is made in the form of a lid 7 inches wide and fits closely into a double rim (X) which prevents the escape of the steam and allows return drippings from the tube to run back into the evaporator through a small perforation. At (W) is a wire loop attached to a cork float showing the water content of the evaporator. If lid (L) is placed in the pan the same distance from the end as from the sides it will be possible to turn the evaporator either across or lengthwise of the stove. The evaporator may be made either of galvanized iron or tinned copper. The flat nature of this pan furnishes a good warming shelf or rest; hence is not a waste of space when upon the stove. Tube (L) of the pan should be 1½ inches in diameter and so made as to slide into tube (E) of the condenser. (A) is a surface, air condenser and water reservoir. It rests upon small brackets upon the wall back of the stove and above the level of the evaporator.

Make the condenser (A) of bright tin into the form of a tight flat box, three inches deep, four foot long and 27½ inches wide. Stock tin usually comes in sheets 20 inches by 28 inches. It can be made longer than four feet to advantage if there is sufficient wall space. (E) is the tube through which steam enters. (T) is a faucet for drawing off the water. (WL) show water line, about five gallons, the condenser will hold at one time. (S) shows two small stream escapes made by fitting tin screw caps over one-fourth inch openings into the condenser. The screw caps are perforated by one-fourth inch holes over which are small bent tubes. These may be so turned as to direct escaping steam away from the wall and prevent the entrance of dust into the condenser.

Figure 3 shows a very effective condenser. It consists of a tin cylinder 7 feet long and 4½ inches in diameter, having a sliding connection (S) for catching the steam from an ordinary tea kettle. This tube slides into a fixed tube so there is no return drop water. This simple distill should be made of bright tin, and costs something less than two dollars to make. At (E) is a small elbow steam escape. The condenser is constructed to hang from a hook (C) in the ceiling by a string or wire connection (AN). When kept in constant operation this still will easily furnish 1 to 3 gallons of water per day. If the kitchen ceiling is sufficiently high the cylinder may be made

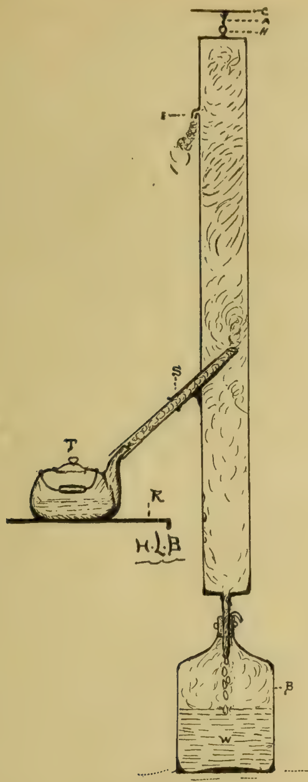


FIGURE 3.

longer to advantage. As it swings behind the stove or range out of the way when not in use, this is a very convenient form of condenser. In making these condensers all seams should be soldered on the outside to prevent the contact of the solder with the drinking water.

THE DEVELOPMENT OF THE BUDS OF THE WILD PLUM (PRUNUS AMERICANA), BY LAWRENCE R. WALDRON.

For those who are interested in the culture of fruits, especially the smaller or garden varieties, it would be an important matter if it were possible to determine the causes underlying the formation of flower buds or fruit buds upon the branches. It is seldom that fruit trees and fruit shrubbery bear fruit regularly every year. Some years the buds are all of a foliage variety or but few if any fruit buds are formed. In order to determine this point it seems quite necessary that a careful study of development of some of the different types of buds should be undertaken. During the school year of 1898 and

1899, Mr. Lawrence Waldron undertook the study of the development of the buds of the wild plum tree. The results accomplished are of such interest that I feel certain they will be of value as a basis for further study and I therefore append an extract of his graduation thesis. The work begun by Mr. Waldron opens up the way for a consideration of the possible causes underlying the setting of fruit buds. The work is also of interest in the fact that, though unknown at the time, Professor E. S. Goff, of the Wisconsin Experiment Station, was also conducting the same study upon the flowers in the cherry, plum, apple and pear. Professor Goff and Mr. Waldron, working separately, have reached essentially the same point in the development of the work and have attained to essentially the same conclusions.

THE EXTRACT.

The work embodied in this paper was first suggested by Professor C. B. Waldron. The plan, enlarged by Professor Bolley, was to gather a number of buds of Prunus Americana each month during each year from a few trees and by a series of freehand sections study, primarily, the time and manner of differentiation of leaf and flower buds, and the influence affecting the formation of flower buds; also a study of the reserve materials and other features which might come into prominence as the work proceeded. Certain phases of the work should be continued at some future time as no very definite results could be arrived at in the time devoted to it.

The freehand method was employed because of the great number of buds studied. In the growing point of a June bud, the dermatogen was easily distinguished. The next three layers were sharply marked off, the third one less than the outer, thus defining the periblem.

Arrangement of Leaves Upon the Growing Point.—While the origin of the members of the bud under consideration is the same, yet, we do not consider one member as developed first and that the other members were modifications of that one, but that the different parts were adapted for use little by little. It does not make matters of plant morphology much more clear to say that a stamen is a modified leaf.

Both leaves and scales have the same vernation, both being imbricated, lapped over each other like shingles. In the case of the leaves a tendency is shown toward obvolute vernation though this is due to the shape of the bud and probably to the mechanical influence of the midrib. The phyllotaxy of the bud scales is two-fifths.

Symmetry of the Bud.—The leaf buds are both radially and bilaterally symmetrical. They are flattened dorsiventrally when formed upon primary shoots of one season's growth. The amount of flattening seems to depend upon the rapidity of growth, the more rapid the growth, the flatter and more triangular in outline they become. Leaf buds formed upon secondary shoots and terminal buds upon all shoots approach the radially symmetrical type. The difference

in the flatness and in the roundness of the bud is due to the difference in pressure exerted by the petiole upon the forming bud. The leaves in the primary shoots are more vigorous than are the leaves of the secondary and so the petiole of the leaf would be less easily pushed aside by the forming bud, and the bud would consequently take the flatter form. The terminal buds have no interference in growth. As the flower buds are formed upon secondary shoots they would tend to be radially symmetrical for the reasons given in the case of the leaf buds.

Comparative Development of the Buds of a Branchlet.—To determine if there were any relative difference in the time of development of the buds of one branchlet, a typical branchlet was selected, gathered on February 15, bearing from base to tip, ten buds. The branchlet was moderately dwarf in character as indicated by the fact of its having six flowing buds. At each of the fifth, seventh and eighth nodes, two buds were present, one flowering and one leaf bud. A careful examination of similar sections from each of the buds showed no apparent difference in the state of development. While the buds developed in acropetal succession, that is, from base upward, it is probable that the difference in time of formation was so slight that at the time of stoppage of growth in the fall, they had all reached the same phase of growth.

Methods of Branching.—Little is to be said regarding the branching of the leaf and flower parts. The flowers grow in umbel-like clusters from scaly buds. The number of flowers in each cluster is four. There may be less when the bud is fully developed, but this is due to the death of one or more of the flowers in the bud. The vegetation shoots branch alternately. The arrangement is the same as that of the bud scales, two-fifths. In the raceme of *Prunus demissa,* the flowers have no regular arrangement upon the axis.

Study of Reserve Materials.—According to Sachs, (Phys. of Plants, pp. 66, 175, 178) calcium oxalate is always to be considered as a waste product within the tissues of the growing plant. "The fact that it is found in growing cells does not alter the fact that it is a useless secretion." It is found in the bud scales from the very first, almost, crystals being found in the second scale from the apical point. In a July bud, the crystals were about as plentiful in the bud scales as in the month previous. No crystals were in the three or four sets of scales immediately surrounding the growing point. The crystals were thickest in the outer set of scales, the central portion of such a scale being closely set with them. The outer scale of one bud contained over fifty crystals that showed in one long section of the scale. The entire scale would thus contain innumerable crystals of the oxalate. In the bud scales, the crystals in the outer sets of scales contained much larger crystals, thus showing continuous accretions to them. The crystals are also numerous in the body of the bud below the meristematic tissue. In a long section of the stem taken from the soft and growing shoot, but very few of the crystals were found. Those present were very small. A

comparison of two sections, one from a very vigorous stem and the other from a dwarf stem, seemed to indicate that the oxalate is deposited in a much greater quantity in the dwarf than in the vigorous bud but this was, perhaps, an exception to the general rule.

By August, the crystals in the outer scales are far too large to be confined to a single cell. The effect is to tear apart the layers of the cells.

The number of crystals found in the scales of flower buds of this month was very much less than the number found in the scales of leaf buds of the same month. This is due to the fact that quite a space of the bud is devoted to the flower parts which, being meristematic, have no recognizable crystals, and to the fact that the scales themselves are much thinner than those in the leaf bud. Even in the outer set of scales, where the crystals are so abundant in the leaf buds, the number and size both seem to be less.

The number of crystals in the lignified portions of the bud scales is less than the unlignified portion of the same scales immediately beneath. Accretions ceased to be made at the time of the complete lignification of the tissues, thus indicating that the lignified portion is a permanent or dead tissue. Because of the smallness of the crystals the layers of the cells of the lignified portion are not torn apart. While the number of crystals appears to be less in the bud scales of the flowering branches, yet this does not hinder the bud scales from splitting longitudinally below the lignified portion. This doubles, in effect, the number of scales surrounding the bud and by producing double the number of air spaces secures perhaps a possible aid for the protection of buds against cold. During the winter months no perceptible change takes place in the number or position of the crystals.

From the fact that there is so much of the oxalate present in the scales almost from the first and that a relatively larger amount is found in the scales than in the leaves of the same age, if the oxalate is a waste product, it appears that the work that the scale has to do is decided from the beginning as the oxalate is cast off in the scales. It is possible that it is of real value there in the scales.

Lignin.—Almost as soon as the young bud is exposed in the axil of the leaf, lignification begins, the scales grow woody and hard. In a bud collected in June, the tips of the outer set of scales showed the lignin reaction. Buds gathered a month later showed three or four sets of scales partially lignified. In the two outer sets, the lignified portion was quite sharply marked off from the unlignified portion but not so sharpely as in later formations. August buds showed further lignification. In some of the buds of this month, seven or eight sets of scales showed more or less lignification. In September buds, the limit of lignification was indicated by a sharp demarkation between the lignified and cellulose portion. In the buds gathered in October, the lignified portion was yet more sharply marked off and the cellulose portion, and here showed the first extended splitting up

into two layers. No further change of moment was observed in regard to lignin except that it became somewhat darker in color as the season advanced.

Cutin.—The buds gathered on June 12th, showed heavy cutinization, cork formation on the outer surface of the bud scales, especially upon the outer scales (Fig. 7). This is added to but little during the later months. The use of the cutin is obviously protection.

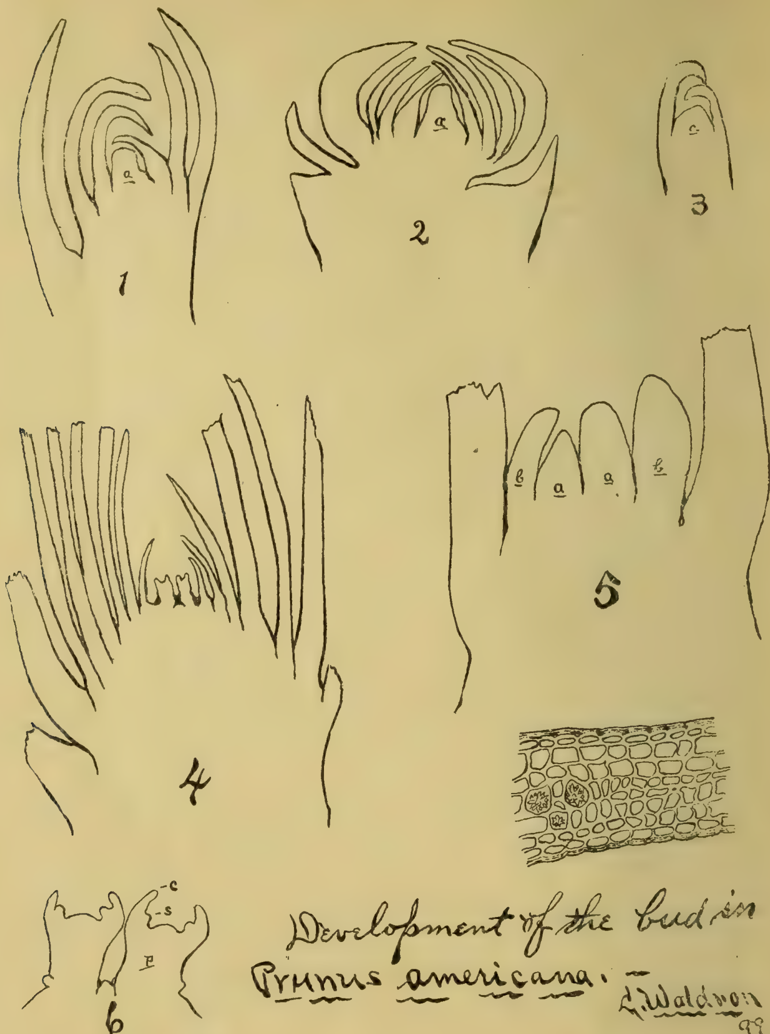
Study of Appendages and Outgrowths.—Considering the bud solely in regard to its functions, the bud scales may be regarded as appendages as they serve only a passive use in the plant.

Outgrowths.—The hairs of the bud are of one kind, unicellular and unbranched. These originate from the epidermis of the scales and leaves, each hair being derived from one cell. Each hair communicates to the base of its cell as is seen in optical section. They occur generally only upon the ventral surface of the scale and of the leaf. In buds gathered in July, a few hairs were seen upon the dorsal surface of the scale but the presence of them here is rare. They develop very early in the age of the scale but do not form a felt until as late as July. In this month the average length of the hairs is 140 microns. The hairs reach their full development in August. When first formed they are composed entirely of cellulose, but in a few weeks lignification begins, extending from the apex downwards. Those upon the young leaves show a much thinner wall and a consequent larger amount of protoplasm than do the hairs of approximately the same age upon the scales.

The function of the hairs upon the scales is probably protection against cold, while those upon the leaf may protect against too rapid evaporation. Air currents would be prevented from reaching to the surface of the leaves when they were once expanded.

Morphology of the Pistils and Stamens.—The freehand sections show quite well the positions of the stamens and pistils. By the 12th of August the flower bud had developed so that the young flowers showed clearly (Fig. 4). In a bud gathered July 12th (Fig. 5) the flowers are seen to be much less developed than those in Fig. 4. This figure is from a higher magnification than other sketches; (a, a) indicate the future flowers. Fig 6 represents the flowers from a bud gathered August 12. At this stage the stamens are not differentiated into anthers and filiaments and appear as protuberances on the base of the calyx. The young flower is now 400 microns long and 275 microns wide. The pistil is 129 microns long and the stamens 67 microns long.

In October the pistil shows first indication of a cleft which will be eventually filled by the ovule and the placenta. The stamens show differentiation into filiaments and anthers, and calyx and corolla parts become quite distinct. The flower is 480 microns long. The stamens 100 microns long. The stamen arising from the calyx can be seen to take the greater part of the vascular bundle, the perianth receiving the remainder.



From October to November the buds changed but little. The buds measured, which were gathered in November, from 525 microns to 550 microns long. The cleft in the pistil becomes more distinct at this time. The buds undergo no change during the winter months. This is interesting, in the fact that the organic parts become differentiated before winter.

In the spring rapid enlargement of all parts takes place; the cleft in the pistil widens, the ovule begins growth gradually curving over upon itself, the filiaments lengthen, and the corolla develops and soon becomes longer than the calyx.

Differentiation of Leaf and Flower Buds.—Until the middle of July, bud scales are being developed from the bud and hence no diffentiation of leaf and flower buds can be detected. From the middle of July to the middle of August, seems to be the maximum time in which differentiation into leaf and flower parts takes place. Of sections taken from buds gathered in September and later, a larger proportion were flower buds than were those gathered earlier. From this it would appear that the time of differentiation extends to a later time than the middle of August. The first indication of the formation of flower buds is a simple cleft of the growing point (Fig. 5). Each part immediately begins rapid growth, and soon stamens, pistils, and perianth may be distinguished as protuberances. Further development is as described.

Conditions Affecting the Formations of Flower Buds.—It was the original intention to give this subject predominence, but the preliminary studies here recorded occupied the greater portion of my available time. The subject is a wide one of vast importance and needs much investigation.

A few facts have been determined. A large quantity of reserve material must be present if flower buds are to be formed. (Sorauer Phys. of Plants, pp. 222.) Certain methods of pruning are known to affect materially the formation of flower buds. A short thick shoot will produce a much higher percentage of flower buds than leaf buds and vice versa.

Reasoning from these facts we see that during the life of the bud there is a critical period in which the future nature of the bud is determined. The problem to be solved is to determine the exact nature and condition of the factors modifying the bud at this period. These determining factors are various and among them may be mentioned; an inherited tendency to produce vegetative or flowering shoots, which may distinguish a strain, any artificial change in the tree which tends to change the amount of reserve food to be stored within, such as top or root pruning, twisting or notching the shoots, etc., the influence of climate, and other known and unknown factors. The nature and extent of influences affecting the formation of the leaf and flower buds have not been ascertained by any precise set of scientific experiments, but they have come rather as the "heritage of the ages." (Sorauer loc. cit.)

As planned at first, four trees were selected in May, 1898, one of which had no fruit, one full fruited, one selected to determine the effect of root pruning, a similar one to determine the effect of top pruning, and a fourth tree from which two limbs were selected, one having no fruit and one full fruited, to determine to some extent the conditions which govern the number of flower buds.

The notes taken in connection with these experiments have been preserved for future use and the following record is made: In the top pruned tree, a count was made of the leaf and flower buds from a branch gathered in December and of a total of 35 buds, 57 per

cent. of these were flower buds. Of the buds found on secondary branches 66 2-3 per cent. were flower buds from a total of 24 buds. On the tree from which two limbs were selected, one full fruited and the other having little fruit, a branch of each was taken to determine the proportion of flower buds. The work was done April 17th, 1899, and resulted as follows: From the limb having no fruit the year before, the number of buds counted was 70, of which 38 per cent. were flower buds. From the full fruited limb the number counted was 78, of which 46 per cent. were flower buds. On May 11th, 1899, the full fruited limb of the year before showed a much larger number of flower buds than did the limb having no fruit. The small number of trees examined forbid the drawing of conclusions.

Methods Employed.—About 175 mounts were made representing about 800 individual sections. By far the greater part of these were cut freehand with the razor and but comparatively few were stained. It was found that treatment of the sections with hydrochloric acid previous to staining with chlor-iodide of zinc produced much more marked results than the use of the chlor-iodide of zinc alone.

The microtome material was fixed in two per cent. chromic acid with a trace of acetic acid, cleared in chloroform and embedded in paraffine melting at 52 degrees. The material was cut with a Bausch & Lomb laboratory microtome set to cut eight and ten microns thick. The sections were treated by Strasburger's method for the removal of paraffine and were strained with borax carmine, methelene blue and carbol-fuchsin. The latter seemed to give the best results.

Summary.—In order to obtain a clear idea of the value of the organs discussed, it is necessary to dismiss the erroneous idea that stamens, pistils and scales are all modified foliage leaves. In place of this we must substitute the idea that all of these organs are modified portions of the tissue of the shoot axis.

The symmetry of the bud is mainly determined by mechanical influences. The buds of one branchlet attain approximately the same stage of advancement when growth is checked in the fall.

The number of flowers starting in one bud is four. This number is often lessened by one or more dying later.

Calcium oxalate is found in abundance in the bud scales in nearly all stages of their growth. It is found in much less abundance in the young leaves and in the young portions of the stem and not at all in the flower parts in quantity that I could demonstrate. It tears the bud scales into two layers, leaving an air space between, which probably aids in protection from cold by furnishing a greater number of air spaces. The number of crystals seems to be less in the bud scales of the flower bud than in the bud scales of the leaf bud.

Lignin commences forming very early in the life of the bud and by September the lignified portion is sharply marked off from the cellulose portion.

A thick layer of cutin is formed upon the dorsal surface of the scale soon after formation.

The walls of the hairs of the scales are much thicker than in those on the leaves of corresponding age.

The organic parts of the flower are formed before winter; the ovule is formed in the spring.

The most important time of differentiation of leaf and flower buds appears to be from the middle of July to the middle of August. There is evidence to show that differentation may take place later.

No deduction from this work can be drawn concerning the factors affecting the formation of flower buds.

June, 1899. L. R. WALDRON.

WEEDS, SEEDS AND NATIVE PLANTS.

During the year 400 new plant specimens have been added to the herbarium, and there has been prepared a large collection of weed seeds. Of the seeds there are now cleaned and bottled over one hundred species in amounts of an ounce or more. These are of much reference value.

SEED TESTING.

The demand for seed examination and seed testing is of the nature of a continuous growth. It is a line of work in which we can be of much aid to the people of the state. I hope during the coming year to place the work of the department, in this line, upon a systematic basis.

Assistance.—My assistance has been such, during the past school year, that I have been relieved of many of the minor features of the College work, with the result, that I have been able to give more close attention to the work of the Station.

Respectfully submitted,

H. L. BOLLEY,

Botanist.

AGRICULTURAL DEPARTMENT.

To Director J. H. Worst:

Sir: The work in this department of the Experiment Station has been continued in lines heretofore reported upon with only minor changes in details. The improvement in varieties of seed grain by selection has been given more attention, and the best one of the 225 collected varieties of wheat has been sent out to the farmers of the state. The seed has been distributed by sale in quantities of five bushels or less per man. Fifty-nine bushels of seed wheat was thus sent to sixteen different men in the state, which together with wheat distributed during other years has put good fife seed into many districts of North Dakota.

The present grain storing capacity of the station limits the quantity of surplus seed wheat which can be stored to about 150 bushels per year. That quantity has been stored and cleaned to be sent out this season. Other strains which have been developed by breeding and selection are coming on and will produce still better seed for future distribution. It is hoped that this work will be allowed to extend to other classes of farm crops, as it promises much good in tangible and direct results for the state.

The study of Bromus inermis(Austrian Brome grass) has been continued in an attempt to obtain facts which will answer the numerous questions now being asked relative to this new grass. Among these trials I may mention studies of manuring, disking, plowing over the sod, annual seeding and seeding with a grain drill as compared with sowing the seed broadcast and harrowing it in. Trials have also been made of scattering the seed upon native sod to see whether it will succeed in making a stand.

The value of brome hay as feed for horses has also been tried in comparison with timothy hay. A trial of threshed brome hay compared with timothy hay for cattle has also been inaugurated and is now in progress.

Other practical points studied are the value of old brome grass sod for pasture and the method and cost of threshing for seed. A trial of the grass for lawn purposes, where no artificial water supply is available has given very promising results.

The trial and introduction of this grass in the various districts of the state has been aided by the distribution of two hundred nineteen, pound samples, to two hundred nineteen persons, in twenty-seven counties in the state since my last annual report. The grass is now growing in every county of the state, while a number of samples have been placed in some counties.

During the past year sufficient seed was produced upon the farm to supply all reasonable demands for the one-pound trial packages, to supply the Station's needs for field sowing and for experimental purposes, and 2,000 pounds to be distributed by sale in lots of 50 pounds or less at the market price. Six hundred eighty-five pounds of it has been sold to fourteen farmers in the state.

The root system of brome grass at different ages has also constituted an interesting and instructive study.

Sixty-three varieties of wheat were grown upon the trial grounds during the past season. A few of them were wheats advertised for this district, and some were varieties brought to America by the United States Department of Agriculture, coming chiefly from Russia. Several varieties which have been bred up by this Station and by the Minnesota Station were also given a trial in the uniform plots of ground used for the purpose. The latter varieties are showing splendid results and will furnish good kinds to be placed in the hands of growers, later.

Thickness of seeding wheat was given another trial, having been planted at eight different rates per acre, ranging from very thick to very thin.

Twenty-six varieties of corn were grown in comparative trial and close observations were made and recorded upon the stages of maturity at different dates during the latter part of the season, beginning at the time when the danger from early frosts will be imminent. Yields per acre of grain and fodder were recorded, together with the amount of moisture in each, at the time when it was necessary to husk and stack it. The study of the thickness of planting corn was extended, twenty-four different thicknesses having been grown. The depth of planting corn was also given attention, trials of six different depths having been made.

Forty varieties of potatoes were grown for comparative study. Potatoes were grown at twelve thicknesses to learn the results. Six depths of planting potatoes were also tried.

Small plots of mangels were grown in order that their yield might be determined.

A number of new varieties of oats were grown and further trial made with kinds which have been grown for one or two years before. The entire number grown upon the variety trial plots was thirty-eight.

Twenty-five varieties of barley were grown in comparison, imcluding some new kinds and several which have been grown less than five years in this trial.

Spelt from seed obtained near Bismarck, N. D., was grown in comparison with some which was introduced by the United States Department of Agriculture direct from Russia, and some which was brought from the same country one year ago and grown here last season.

Three plots giving trials with flax and wheat mixed were grown

and the yields recorded. Flax was sown at nine different rates or thicknesses per acre.

Flax from imported samples and from two different local sources, making four kinds in all, was grown in a comparative trial.

Six varieties of buckwheat were grown, one of which proved to be very promising. It was introduced by the United States Department of Agriculture.

Six varieties of field beans were grown and the results duly recorded. Three plots of beans planted at different thicknesses were grown. Fifteen varieties of millet were grown in a comparative trial. Several of these were from seed introduced by the United States Department of Agriculture, while several others were of varieties advertised in this state.

Trials with rape for sheep and milk cows were made.

Four bulletins, numbers 36, 38, 39 and 40, were published by this department during the past year.

Bulletin No. 36 gives the result of an interesting and extended study of the root systems of crops. In addition to the root study a complete mechanical analysis of the soil was made. The study of root systems of plants was continued during the past season, brome grass, timothy, native prairie sod, flax, sugar beets and potatoes having received attention. I regard this study important and one which aids in many considerations of plant life. That study will need some further attention to determine the regularity with which the roots of important farm crops descend, to the depths noted, and form the kinds of root systems which they had during the season which was reported upon in bulletin No. 36. If a similar study could be made of wheat and brome grass rooting systems upon other classes of soils in this state, I believe valuable information would be obtained.

Bulletin No. 38 contains a discussion of the results obtained from cultivation trials and from moisture and temperature studies. Following is a brief summary of its contents:

SUMMARY.

1. Fall plowed land gave one bushel per acre heavier yield than spring plowing, as an average for seven years trial.

2. Wheat sown in drills and cultivated gave a yield of ten bushels and twelve pounds less per acre than wheat sown in the ordinary way.

3. Ground plowed with the Secretary disk gang plow yielded 50 pounds less per acre than that plowed with an ordinary moldboard plow.

4. Sub-soiled land gave an increase of 54 pounds per acre but at greater cost, making the net profits 42 cents less per acre upon sub-soiled land.

5. Harrowing land immediately after plowing gave an increase of 39 pounds per acre in yield and an increase in net profit of 25 cents per acre.

6. Land sub-surfaced packed gave one bushel and six pounds

greater yield than land not packed and 61 cents greater net profit per acre.

7. Deep plowing gave 43 pounds greater yield per acre than shallow, and 37 cents greater net profit.

8. Rolling and harrowing land after seeding gave an increase of three bushels and 11 pounds per acre in yield, and $1.25 in net profit as a result of a single trial in the season of 1898.

9. Harrowing wheat one week after seeding caused an increase in yield of two bushels and one pound and an increase in net profit of 72 cents per acre.

Bulletin No. 39 contains a statement of the results obtained from the trials made with field crops. Following is a brief summary of the results:

1. Of the 39 varieties of wheat tested in 1898, the two standing highest in grade and yield were Selected Haynes' Blue Stem (No. 214), and Selected Rysting's Fife (No. 215). Both varieties were originated from single plants by careful selection.

2. As an average result from five years' trial, Bolton's Blue Stem (No. 146), gave the highest average yield.

3. As an average result from seven years' trial, Experiment Station Fife 66 stands first in both yield and grade.

4. The data which have been obtained on the effect of changing seed wheat, indicates that nothing is gained by a change of seed if a change is the only thing accomplished. If a better variety, or a better strain of the same variety can be obtained, the change of seed may be well worth the cost.

5. Five and one-half pecks of seed wheat per acre gave the largest average yield for the several trials.

6. The depth of sowing wheat in 1898 had but slight effect upon the yield. Two to three inches seem to be the best depth.

7. Tartarian oats (No. 26) stands at the head as the largest yielder in a five years' test.

8. The thickness of sowing oats, from five to ten pecks per acre respectively, had very little effect upon the yield of grain.

9. Oats sown three to four inches deep gave the best average yields last season.

10. As the result of four years' trials, Mansury barley (No. 7) has given the largest yield.

11. The results of a single trial favor three inches as the depth for sowing barley.

12. Trials with spelt indicate that it is equal to barley in yield, and its chemical analysis shows that it is equal to barly or oats as a feed for stock. It is worthy of a trial by the farmers of our state.

13. Rye has not proved a profitable crop at this Station.

14. Early varieties of buckwheat may be grown with profit in the eastern part of North Dakota.

15. The season of 1898 was too short for the full maturing of even the earliest varieties of corn. Gehu, Will's Acme, Will's Da-

kota, Mercer, Smut Nose and Northwestern Dent are among the best varieties for this locality.

16. None of the varieties of kaffir corn have matured at this Station in any season. It cannot compete with Indian corn as the varieties now stand.

17. Corn sown broadcast gave a little lighter yield than that sown in six inch drills. The largest yield both of grain and fodder was obtained from the corn planted in drills 24 inches apart.

18. Corn planted in rows three and one-half feet apart and cultivated, gave the greatest yield of fodder and ears when planted one kernel in a hill and six inches apart in the row.

19. Corn planted more than five inches deep came up poorly. That planted two to four inches deep gave the best yield in 1898.

20. Only the earliest varieties of potatoes ripened in 1898. The results of a single trial, place Early Andes at the head in yield and equal to Early Ohio in quality and earliness of maturity.

21. Early potatoes planted in hills ten inches apart with the rows three and one-third feet apart gave the largest yield recorded last season. Doubling the amount of seed planted in a hill did not increase the yield but seemed to increase the percentage of small and scabby potatoes.

22. A single trial indicates that four to five inches is the best depth to plant potatoes in this soil and climate.

23. The results from a six years' trial in rotation of crops, show that it does not pay to raise wheat continuously. By rotating wheat with cultivated crops, larger yields are obtained and a better quality of wheat.

24. Land which produced three crops of wheat and one cultivated crop in a period of four years, gave almost as much wheat and more profitable returns than did the land which produced four crops of wheat in succession.

Bulletin No. 40 contains the results of experiments and observations made upon the cultivated grasses and forage crops.

In accounting for my time I will perhaps be justified in stating that the answering of 170 letters of inquiry upon specific farm topics by means of personal letters has required a considerable portion of time and the expenditure of some energy.

A. M. Ten Eyck, M. S., has acted as assistant agriculturist during the past year. I wish hereby to make the public recognition which is due him in filling that position.

My thanks are due Mr. H. M. Ash for efficient and painstaking work in the discharge of the duties assigned to him during the past season.

Respectfully submitted,

J. H. Shepperd,

Agriculturist.

DEPARTMENT OF HORTICULTURE AND FORESTRY.

To J. H. Worst, Director:

The work in this department was for the most part a continuation of the experiments outlined and started in 1898.

The same plots were used for trials with the different fertilizers and these were applied in the same order and amount as for the previous season.

A condensed record of a part of the work done along these lines will be found in bulletin No. 42 issued in December, 1899. The exact results shown in the different yields cannot be given here, but the following, taken from the bulletin is a general summary of the work:

In the spring of 1898 a series of experiments was inaugurated to determine the influence of different classes of fertilizers upon different garden vegetables. The points to be noted were:

First—The influence upon total yield.

Second—The influence upon quality and habit.

Third—The influence upon maturity or time or ripening.

Fourth—The influence of different elements at different stages of the plant's growth.

Fifth—The effect that the different fertilizing elements, applied in the early stages of growth, might have upon the subsequent development of the plant, and

Sixth—The relative value of the different animal manures, applied to the same problems as above.

This work was continued through the season of '98 and '99. The report now presented touches only upon points one and three, and the results under these heads are largely negative.

Under the heads four, five and six we have complete notes of some positive and rather striking results, the publication of which is deferred until they can be confirmed by another season's trial, and also until fuller photographic records can be obtained.

The most striking part of the experiments is the apparent indifference of the soil to any and all fertilizers.

The great uniformity of the soil in the Red River Valley would render any experiments affecting the total yield of considerable importance, but so far all we can say is that the manner in which the soil is handled has far more to do with the returns than a heavy application of the best fertilizers. The work so far would indicate that the time and depth of plowing, protection of the soil in winter, manner of cultivating, time of seeding, transplanting, etc., are lines

offering a better opening for experimentation than the one here recorded.

It was found that the larger sorts of onions transplanting gives much the best results, and the gain is considerable, even with the ordinary sorts.

The Gibralter makes a better showing than the Prizetaker, both in size and quality.

The difference in behavior between certain varieties of the same vegetable may be accounted for in some instances, as in beets, on the basis of different habits of growth; in other cases no explanation seems possible.

The publication of the notes under points four, five and six will furnish material having a general value, and not confined alone to the Red River Valley.

The general work with fertilizers will be discontinued and only special lines of the work carried on, such as the result of different elements when applied at different stages of growth, and the effect of an early application upon the subsequent development of the plant.

The results obtained show that a single trial, upon rich soil of any given fertilizer is no test of its value. Even when applied to different varieties of lettuce, cabbage, etc., the results are conflicting and often contradictory.

The following varieties of vegetables make the best showing:

Beets—Edmond's and Wilson's Improved.

Onions—Gibralter for size and early market and Australian for good keeping qualities.

Cucumbers—White Wonder and Hill's Forcing.

Cabbage—Early Summer, Washington Wakefield and Early Spring for early, Succession and Marblehead Mammoth for the main crop.

Lettuce—Dwarf White Heart, Prizehead, Thickhead Yellow and Early Curled Silisia.

Tomatoes—Early Minnesota and Early Michigan.

Beans—Valentine Wax, New Stringless.

Radish—Cincinnati Market, Earliest White.

Peas—Advance, Gradus.

Carrots—Model and Short Horn.

Sweet Corn—Early Sheffield, Banana and Russia No. 2799.

Popcorn—Mapledale Prolific.

Of small fruits all of the thirty varieties of currants and gooseberries grew well and most yielded full crops of fruit. The Cuthbert raspberry yielded heavily and the Turner also did well. The DeSota plum trees produced to their full capacity and some of the wild types were hardly behind them in quality or productiveness. Nearly half of the wild plum trees were found dead in the spring; the roots were entirely killed. The cause was not determined, but was wholly unlooked for, as the trees had always been exceptionally vigorous. These trees were grown from pits brought from Iowa,

Trees of the same species taken from native thickets suffered no injury. This may have been accidental, but probably was not, as the Iowa stock suffered but little where it was well protected.

All of the apples made a good growth and contrary to our usual experience, did not suffer from blight.

The Moore's Early was the only grape to ripen its fruit and the season was exceptionally favorable.

FORESTRY.

Until the past season we have always recommended the White Ash as the most promising tree for groves and timber belts. During the last year it has shown itself subject to very serious attacks from borers and from a bark beetle that appeared in such numbers as to destroy or cripple nearly all the trees. The bark beetle (Scolytidæ sp; indt.) work just beneath the bark and girdles the tree in numerous places, leaving only a small strip on the south side. There is no practical remedy and judging from the present outlook the tree must be abandoned.

In Bulletin No. 41 issued by this department in September under the head of "Hints on Ornamental Planting," the value of different trees for general planting is discussed.

The elm for general planting doubtless ranks first, but failure is sure to result in the cultivation of this tree unless one is very particular to employ exactly the proper methods at the start. In the bulletin referred to full cultural directions are given for this and other forest trees.

INJURIOUS INSECTS.

During the month of June, I spent considerable time in the vicinity of New Rockford and also at Rolla, on account of the appearance of the Rocky Mountain locust at these places.

Plowing was begun in most of the stubble fields while hatching was still in progress and the young were too small to make their escape. In most fields the work was pushed so vigorously as to destroy practically all the young insects, but in both regions three or four fields were left until a considerable number made their escape. Of these that succeeded in reaching the grain field by far the greater number, and in some districts all, left before they deposited their eggs.

If there are any outbreaks from this pest next season they will be very limited and easily checked if taken in time. By driving over all the infested regions and calling attention of the farmers to this insect and the danger of allowing it to remain and multiply, an intelligent interest was created that is likely to make living rather precarious for the grasshopper that takes up his abode in this state.

An insect that did far greater damage in the state last year than the grasshoppers have done in all the years is the Hessian Fly. So far this has not been considered a very dangerous pest in spring wheat belts, especially in regions of high latitude having a dry

climate. This supposition may yet prove to be true, and the great numbers and wide range of the insect the past season may be found an exception to what we may usually expect. If our natural conditions are such as to make it difficult for this insect to pass in considerable numbers from one season to the next, then an emphasis of these conditions such as we experienced during the past season in a very long, dry and sunny fall, ought to quite exterminate the present brood.

As a rule I have found the farmers of the state unacquainted with the Hessian Fly and its habits, so a description of its life history will not be out of place.

In June the adult females, much like the mosquito in general appearance, though no more than half as large, deposit their eggs upon the leaves of the young wheat plant. The leaf selected is usually the one coming from the second joint above the ground. The egg soon hatches and a tiny grub crawls along the leaf to the stalk where it finds a place between the leaf stalk, which it appropriates as its permanent home. While it has no further power of movement, yet it feeds upon the juices of the plant and of course the straw becomes much weakened at the place where the grub is located. During the latter part of July if it is noticed that a considerable number of the straws are small and weak with but little or no grain in the heads, then the presence of the Hessian Fly may be suspected. If present it appears as a nearly transparent whitish grub about one-eighth of an inch long. Still later in the season just before harvest most of the infected straws bend over abruptly just above the second joint or where the grub is found. By this time the grub has changed appearance, for the larvae has passed into the resting stage, and is now a brown shing inactive object to which the name "flaxseed" is commonly given. In the winter wheat regions of the middle states this brood would give rise to a second one before winter that would lay eggs in the fall sown wheat, but here the "flaxseed" stage found at harvest time undoubtedly endures till the following spring or early summer before the adults emerge.

From August till the following May or June is a long time for puparia protected only by the old wheat leaf and their own thin covering, to retain their vitality.

Through the kindness of the Northern Pacific Railway Company I was enabled to visit several fields about Grafton late in November and at that time more than half of the puparia were alive and uninjured. I collected several hundred of them to make a test of their vitality, but the conditions under which they are now kept are not identical with field conditions. Only frequent visits to fields in the infested regions will enable one to determine the per cent that live through the resting period and the time at which they emerge as adults in the spring.

The remedial measures for the Hessian Fly are simple and do not entail additional expense. Badly infested fields should be cut

high and the stubble burned. If this is not possible plow in the fall or early the next season. How early will depend on what time the adults emerge, a matter not yet fully determined for this latitude, but probably the plowing should not be later than the first of June.

Parasites or unfavorable climatic conditions might destroy all of the insects making any measures of prevention unnecessary.

In the absence of state provision for work of this character, and considering the inability of the Agricultural College to spend its funds for such work, the railroads have been asked to furnish the necessary transportation, and have usually granted the request.

The incidental expenses of the trips are sometimes borne by the counties in which the damage occurs and also by citizens who are interested.

As any insect outbreak is likely to be of more than local interest it has been suggested that a small appropriation from the state should be placed at the disposal of some one whose duty it is to look after insect invasions, sending out such publications and reports as will assist in checking the damage, or in other ways furnishing such aid and advice as would naturally be expected from one holding the position of state entomologist. Small insect outbreaks are often magnified into serious affairs by papers outside the state, and in such cases the state would profit by having some one whose position enables him to speak with authority in matters of affecting her welfare and reputation. Such work is no one's duty now, and what has been undertaken in the past was done by private parties not always directly interested.

Respectfully submitted,

C. B. WALDRON,

Horticulturist.

DAIRY DEPARTMENT.

To Director J. H. Worst:

Sir: During the past year the work of the Department of Dairying has been entirely along educational lines with the exception of such feeding and milk records and tests started early in 1897 and continued to the present time.

There has been two reasons for not doing any experimental work in dairying. First, I have had to take entire charge of the Department of Military Science and Tactics, which requires from six to ten hours teaching per week, and the first half of the year taught a class in United States History five hours per week.

All other members of the station staff who have had any teaching to do have assistants who can either conduct the class work or do the experimental work under the direction of the head of the department. Second, North Dakota dairymen are in more need of instructions in the principles of buttermaking than along experimental lines.

No bulletins have been published by the department during the year, the instruction being given in such classes as attended the College, in farmers' institutes and by personal correspondence. More work of this nature is being demanded than ever before, showing an increasing tendency to engage in dairying.

There is undoubtedly a wide field for experimentation in this state, and it is only a short time when the dairymen of the state will compel matters to be so adjusted that a complete line of experiments can be carried on in this department. Under present conditions I cannot do it, neither could any one else.

The acknowledgments of the department are again due to the publishers of Hoard's Dairyman, Chicago Dairy Produce, Creamery Journal, Creamery Gazette, Practical Dairymen, Milk Reporter, Produce Review, Elgin Dairy Report, Dairy World, Dairy and Creamery, Jersey Bulletin, and Western Creamery, for copies of their valuable papers.

Respectfully submitted,

E. E. Kaufman,

Dairyman.

DEPARTMENT OF VETERINARY.

To Director J. H. Worst:

Sir: I take great pleasure in transmitting my first monthly report since occupying the position of chief state veterinarian. Since assuming the duties of such office nothing of any great importance has transpired. There has been no outbreak of contagious diseases to any extent. Dr. A. F. Elliot of the Seventh District reports that he destroyed six horses suffering from glanders, owned by Mr. Fitsimmons, of Neche, and the remainder of his herd was quarantined. All necessary precautions have been observed to prevent the spread any further.

There have been a number of requests for Anthrax Vaccine, and I expect to see more cattle vaccinated this coming spring than any previous year.

There have been also a number of requests for Mallein and Tuberculine.

I have been notified by the Montana state veterinarian that there exists a disease on the Montana and North Dakota line, known as cattle scab or Mange, so the district veterinarians near the line are making some investigations, and if found prevailing all the steps necessary will be taken to get the disease under control.

The general health of the stock of the state I may say is good.

Respectfully submitted,

Dr. J. W. Dunham,

Veterinarian.

CONCLUSION.

An examination of the reports from the several heads of the Station departments show that the work of adaptation of cereals and plants to local conditions, and their improvement by selection and breeding is continued from former years, and that due attention is given to diseases affecting plants and grains. Methods of cultivation are given considerable attention, and animal husbandry comes in with a fair share of attention in a general as well as experimental way.

New questions are constantly arising that should be given larger attention, and many useful experiments that should be made have to be deferred for lack of funds to employ the requisite help. The Station will continue in the future as in the past to work along the most practical and useful lines, giving preference to what is useful to the farmer, rather than what may prove more interesting than practical.

Respectfully submitted,

J. H. Worst,

Director.

STATEMENT.

GOVERNMENT AGRICULTURAL EXPERIMENT STATION FOR NORTH DAKOTA IN ACCOUNT WITH THE UNITED STATES APPROPRIATION, 1898-9.

DEBTOR.

To receipts from the Treasurer of the United States as per appropriation for fiscal year ending June 30th, 1899, as per Act of Congress approved March 2nd, 1897	$15,000.00

CREDITOR.

By salaries	$ 7,725.00
Labor	2,870.77
Publications	1,033.27
Postage and stationery	144.67
Heat, light and water	331.11
Chemical supplies	.30
Seeds, plats and sundry supplies	265.01
Freight and express	178.26
Feeding stuffs	192.50
Library	28.50
Tools, implements and machinery	406.35
Furniture and fixtures	18.75
Scientific apparatus	50.50
Live stock	800.00
Traveling expenses	133.35
Contingent expenses	45.75
Building and repairs	740.91
Fertilizers	35.00
	$15,000.00

SUPPLEMENTARY STATEMENT.

DEBTOR.

To balance on hand June 30th, 1898	$ 494.34
To receipts from other sources than the United States for the year ending June 30, 1899	2,782.91
	$ 3,277.25

CREDITOR.

By salaries	$ 180.00
Labor	1,724.92
Heat, light and water	30.68
Seeds, plants and sundry supplies	956.46
Feeding stuffs	55.80
Tools, implements and machin ry	19.14
Live stock	276.50
Contingent expenses	25.00
Building and repairs	8.75
Total amount	$ 3,277.25

R. A. SHATTUCK,
Secretary.

LIBRARY
OF THE
UNIVERSITY of ILLINOIS.

ELEVENTH ANNUAL REPORT

OF THE

NORTH DAKOTA

Agricultural Experiment Station

AGRICULTURAL COLLEGE, N. D.,

TO THE

GOVERNOR OF NORTH DAKOTA.

February 1, 1901.

BISMARCK, N. D.:
TRIBUNE, STATE PRINTERS AND BINDERS,
1901

STATION STAFF.

J. H. Worst, LL. D.	Director
E. F. Ladd, B. S.	Chemist
C. B. Waldron, B. S.	Horticulturist
H. L. Bolley, M. S.	Botanist
J. H. Shepperd, M. S. A.	Agriculturist
L. R. Waldron, B S.	Assistant Botanist
A. M. Ten Eyck, M. S.	Assistant Agriculturist
H. M. Ash	Foreman in Agricultural Department
C. D. Porter	Foreman in Horticultural Department
Herman Croft	Herdsman
J. Jessen	Assistant Herdsman
R. A. Shattuck	Secretary

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LETTER OF TRANSMITTAL.

Fargo, N. D., February 1, 1901.

To His Excellency Governor Frank White, Governor of the State of North Dakota:

Sir: As required by act of congress, approved March 2, 1887 and section 13, chapter 160 of the laws of 1896 for North Dakota, I hereby submit the eleventh annual report of the North Dakota agricultural experiment station for the year ending February 1, 1901, together with a financial statement of receipts and disbursements as required by law, for the government fiscal year ending June 30, 1900.

Very respectfully yours,

W. H. ROBINSON,

President Board of Trustees.

REPORT.

To the Board of Trustees of the North Dakota Agricultural College and Experiment Station:

Gentlemen: I have the honor to submit to you the eleventh annual report of the North Dakota agricultural college and experimental station. The past season was marked by general and continuous drought during the spring and early summer months, followed by unusual precipitation during the later summer months and autumn. As a result the crops were more than usually sensitive to cultivation methods and systems of rotation. The experimental work was therefore greatly affected by the abnormal weather conditions but not the less interesting and instructive. The data collected during the year is very important.

The following bulletins were published during the year:

No. 43. A study of the root systems of cultivated plants grown as farm crops.

No. 44. (1.) Water hemlock poisoning.

(2.) Preserving eggs.

No. 45. Feeding trials with work horses.

1. Roughage.

(1.) Brome hay.
(2.) Timothy hay.
(3.) Oat straw.

2. Grain.

(1.) Oats.
(2.) Barley.
(3.) Malt.
(4.) Corn.
(5.) Wheat.
(6.) Bran and shorts.

No. 46. Preliminary list of the seed bearing plants of North Dakota.

On the morning of January 4, 1901 we had the misfortune to lose our large general purpose barn by fire. All of the contents except the horses and cattle, several vehicles and some minor implements were destroyed. The barn men lost all their personal effects, several of them losing quite heavily, in their generous efforts to save the property of the college and station and merit your commendation for the sacrifices they made.

Many valuable varieties of grain were burned which will prove a serious loss to the experiment station. The barn and contents were fully insured and satisfactory adjustments were made by the several insurance companies. The college received $11,-853.80 which will enable us to rebuild early in the spring. I would recommend the erection of two barns instead of one.

A stable 28x80 feet has been constructed for temporary shelter for the horses. A similar structure will be necessary for the cattle in the near future.

The station is under great obligations to Mr. James K. Kennedy for the use of his barn, situated on 11th Avenue North, where the stock was temporarily housed after the fire and where the cattle can be sheltered until spring.

Since my last report farmers' institutes were held at Lakota, Larimore, Milton, Edgeley, LaMoure, Monango, Pembina, Blanchard, Park River, Aneta, Langdon, Walhalla, Grafton, Neche, Hamilton, Mayville, Hope, Milton, Rolla, Bottineau, Foreman, Havana, Rolla, Devils Lake and Churchs Ferry. These institutes were conducted under the direction of Prof. E. E. Kaufman, assistant dairy and food commissioner, assisted by members of the station staff. This work was in addition to their regular duties as experimenters and teachers. A number of institutes are scheduled for the winter and spring months, but about thirty-five applications for institutes were rejected for want of time to conduct them, owing to the large enrollment of students for the special courses in agriculture.

The demand for farmers' institutes is now beyond our facilities to conduct them without a sufficient appropriation by the legislative assembly to organize a paid corps of institute conductors whose entire time can be devoted to such work during the winter months. The interest manifested by the farmers in such institutes and their evident helpfulness to farming communities fully warrants their being fostered by the state. Mr. T. A. Hoverstad of the Crooks ton, Minnesota station rendered valuable assistance at a number of institutes for which the station staff is under obligations. The station is also indebted to J. A. Power of Power, and Ernest G. Schollander of Montpelier, a student now in college, for assistance at several institutes.

The annual report of the experiment station contains much valuable information for farmers and should be widely distributed. Other agricultural states send out their station reports, containing from three to eight hundred pages each, by the thousand, to those interested in agriculture. Under our present system but a few dozen are available after sending copies to the departments at Washington, to station libraries and to station workers throughout the United States, as required by law. The report contains a resume of the year's work which does not find

its way into the bulletins, and but few farmers can obtain it until arrangements are made for its more liberal distribution. Provision should be made for the publication of several thousand copies for gratuitous distribution among the farmers of the state.

The department of agriculture has entered into a contract with the department of agriculture at Washington to co-operate in a series of experiments and will receive joint credit for the work accomplished.

I respectfully call your attention to the subjoined reports of the several members of the station staff.

J. H. WORST,
Director.

CHEMICAL DEPARTMENT.

To J. H. Worst, Director:

Sir: I submit my eleventh annual report for the department of chemistry for the year 1900.

The work of this department has included a wide range of subjects and a large share of the time of an assistant has been devoted to routine work made necessary for the demands of farmers for assistance in many lines, such as water examination, soil testing, testing formaldehyde, etc.

The work of the chemical department has been seriously handicapped for want of proper room to conduct lines of investigation that should be taken up or even in carrying forward the work we now have in hand.

When all lines of chemical work must be carried on in the same rooms and a large share of one's energies and time must be devoted to setting up and taking down apparatus that should have a fixed place, but little real advice can be made. Until this department can have laboratory facilities adequate for its demands but little can be accomplished, by the department of chemistry, of lasting benefit to the agriculture of the state. The department has, we believe been able to render direct benefit to the state in the matter of soil studies and in calling attention to proper methods for conserving soil fertility, that should be the means of largely improving the agriculture of the state. Again in demonstrating the cause for the loss of so much stock due to poisoning from eating water hemlock often found in "slough" hay. The department has benefited the farmers. One stockman reports the loss of fifty-two animals in a single winter, the

cause being unknown at the time, but he is now confident the loss came from this plant which was abundant in the hay and the properties of which he did not know at the time.

During the past year as in previous years a large number of animals were poisoned by eating this plant. Bulletin No. 44 contains a description of the plant and its properties together with other information.

Since 1891 sugar beet experiments have been continued and this investigation has been carried out by this department until it is well demonstrated that North Dakota is favorably situated and that the south part of the state, at least, comes well within the sugar producing belt of the union. The resuult of these co-operative experiments has attracted the attention of capitalists, and it is reported that a beet sugar factory is to be built at Oakes, one of the most favorably located points for such an industry.

Judging from our examination of the beets grown in the region about Winona, it should be a favorable section. The location on the banks of the Missouri affording such cheap and excellent means of transportation for coal, beets and even the manufactured sugar would seem to warrant further experiments in this region. During 1901 it is proposed to make Winona and Jamestown the two focal points, about which special sugar beet experiments will be undertaken.

It is proposed also during the present year to plan and execute experiments to determine the fitness of North Dakota soil and climate for producing pears, beans, corn and tomatoes suitable for canning and to aid in establishing such an industry in what seems to be well adapted localities in the state.

Much of the analytical work for the past year has been carried out by my assistant, Mr. Hugh McGuigan, who has very carefully and well performed the duties assigned him.

During the past year I have been present and spoken at seven farmers' institutes in different parts of the state, and at the grain growers' convention at Fargo. Some time has also been devoted to nature study work in preparing an outline for the rural schools of the state. The course begins with simple observation work for the youngest pupils and leads up to the principles of agriculture to be taught during the last two years of the common school course. It is believed this educational work will be of benefit to the station, as the pupils will have some knowledge of the science of agriculture, hence will derive more benefit from the bulletins sent from the station.

WHEAT STUDIES.

It is a notable fact in the analysis of wheats from year to year that there has been a gradual falling off in the per cent of proteids and gluten contained in our wheats, grown in North Dakota.

A few determinations of the per cent of nitrogen in wheats from individual heads have been made, also examinations have been made of the heads from individual stools. Our object being to determine to what extent there might be variation in nitrogen content, and whether there was uniformity for heads of the same stool.

Both fife and blue stem wheats were analyzed and the results from each head and for the individual heads in each stool are given below for a few samples under examination.

1	2.24	14.00
2	2.52	15.75
3	2.53	15.81
4	2.20	13.75
Average	2.372	14.82
6	2.45	15.31
7	2.81	17.56
9	2.56	16.00
Average	2.606	16.29
11	2.92	18.25
12	2.43	15.50
15	2.66	16.62
Average	26.87	16.79
21	2.17	13.56
22	2.28	14.25
23	2.44	15.25
24	2.56	16.00
Average	2.362	14.76
43	2.92	18.25
44	2.55	15.94
Average	2.735	17.09

74	2.34	14.62
77	2.15	13.44
82	2.36	14.75
83	2.57	16.17
Average	2.355	14.74

An inspection of the preceding table shows individual heads to range in proteid content from 13.56 per cent to 18.25 per cent, a range of 4.69 per cent, while the mean for the stools have varied from 14.74 per cent to 17.09 per cent.

About one-half the seeds in each head was used for analysis and the balance of each head has been saved for planting in order to determine whether seed with a high proteid content will produce seed of like quality and whether those of low proteid content will propagate like the parent seeds.

The work in seed selection of wheat heretofore, so far as I am aware, has been along the line of selecting the seed from general appearance and growth of the plants. It was our thought that possibly by selecting seed from heads having a high gluten content some improvement could be made along these lines, and result in developing a wheat with a uniformly higher gluten content. Corn is also being examined in a similar manner and the results of the outcome of these experiments with wheat and corn are awaited with considerable interest, for judging from experiments in other lines we feel justified in expecting that considerable improvement may be made following out this line of work.

SUMMARIES OF TEMPERATURE, RAINFALL AND SUNSHINE.

The past year has been very exceptional and it may almost properly be said to be both the driest and wettest year during the ten years of our records at Fargo. It was the dryest the first half of the year when grains needed moisture to produce a crop, and the wettest during the last half of the year, giving the largest rainfall for any year during the life of this station.

The following table gives the maxima, minima and mean monthly temperature for the year 1900:

	Maximas	Minimas	Means	Rainfall in inches
January	52	—25	14.1	0.45
February	35	—30	-1.2	0.54
March	55	—15	19.6	1.23
April	87	15	19.6	1.82
May	97	24	50.0	0.81
June	98	31	66.0	2.11
July	101	40	67.1	3.91
August	93	42	72.8	8.28
September	90	26	56.5	3.27
October	31	22	49.7	2.80
November	59	—15	20.0	0.20
December	38	—17	14.1	0.12
				25.54

MONTHLY RECORD OF SUNSHINE.

The hours of actual sunshine given in the following table is the amount recorded by means of a Friez photographic sunshine recorder, but contains no correction for early morning and evening sunshine unrecorded by the instrument.

To these records should be added about 12 to 15 per cent for the unrecorded sunlight, while the rays of light are not strong enough to produce a record.

SUNSHINE RECORD

	1899					1900				
	Total hours possible	Total hours recorded	Daily mean hours possible	Daily mean hours recorded	Percentage of sunshine	Total hours possible	Total hours recorded	Daily mean hours possible	Daily mean hours recorded	Percentage of sunshine
January	279.0	87.3	9.0	3.0	31.3	279.0	98.5	9.0	3.4	37.8
February	273.1	141.6	9.8	5.1	51.9	273.1	136.6	9.8	4.9	50.0
March	369.0	205.9	11.9	3.6	55.5	369.0	174.9	11.9	5.6	44.9
April	394.3	243.0	13.1	8.1	61.6	394.3	259.6	13.1	8.7	65.8
May	466.3	182.5	15.	5.9	39.1	466.3	319.6	15.	10.3	68.2
June	474.9	250.	15.8	8.3	52.2	474.9	259.6	15.8	8.7	55.1
July	480.2	306.25	15.5	9.88	63.7	480.2	269.6	15.5	8.7	56.1
August	441.8	189.0	14.3	6.4	42.8	441.8	161.9	14.3	5.2	36.4
September	378.3	222.6	12.6	7.4	58.7	378.3	148.4	12.6	4.9	38.9
October	336.6	100.4	10.6	3.2	29.4	337.6	104.1	10.6	3.4	31.2
November	281.6	110.7	9.4	3.7	39.3	281.6	103.1	9.4	3.4	36.6
December	267.1	127.6	8.6	4.1	47.7	267.1	80.6	8.6	2.6	30.2
Total and means	4443.2	2166.85	12.1	5.97	48.8	4443.2	2116.5	12.1	5.7	47.1

We present below the total rainfall of years beginning with 1892, as recorded at this station.

	1892	1893	1894	1895	1896	1897	1898	1899	1900
Total rainfall..	20.73	16.17	18.72	16.85	20.36	22.30	16.20	21.21	25.54

This gives the mean annual rainfall of 19.78 inches for the past ten years and an excess of 5.76 inches for the past year above the average for the ten years.

CALCULATED AND RECORDED DAILY TEMPERATURES.

The question has been frequently raised as to whether the mean temperature for a day as calculated for the reading of the maximum and minimum thermometers was a correct record for this climate. Following we give both the calculated temperature and the daily average as actually recorded by means of a Draper's self recording instrument and the records made from each hour record for the full day of twenty-four hours.

	April		May		June		July		August		September	
	Recorded	Calculated	Recorded	Calculated	Recorded	Calculated	Recorded	Calculated	Recorded	Calculated	Recorded	Calculated
1	....	9.5	41.1	40.	53.9	60.5	75.0	65.5	96.9	64.	70.8	73.
2	....	6.0	46.4	45.	61.4	64.0	62.7	64.5	67.9	63.	63.0	61.5
3	....	14.5	45.7	45.	65.9	67.0	67.4	63.5	67.3	67.0	58.2	55.5
4	27.0	22.5	30.7	40.5	61.9	65.5	67.1	63.0	64.1	63.0	71.1	66.5
5	31.8	27.5	50.5	53.5	59.6	61.0	69.7	70.0	66.3	63.5	60.3	58.0
6	28.9	27.5	59.8	58.	61.2	62.0	68.8	65.0	66.8	70.0	65.2	66.0
7	36.3	33.0	....	60.5	62.8	55.5	69.6	65 0	71.3	70.5	59.6	57.5
8	33.3	39.5	59.3	57.0	50.1	53.0	58.8	63.5	71.0	67.5	59.9	57.5
9	41.3	41.0	57.5	65.	63.1	58.5	71.5	72.0	69.9	70.5	66.8	64.0
10	45.0	49.0	65.6	71.5	64.9	64.0	71.2	71.5	69.6	72.0	60.6	61.5
11	47.0	46.0	56.5	63.5	67.2	67.5	72.9	71.0	65.7	69.0	66.0	65.5
12	54.1	54.0	68.4	44.	63.8	67.5	72.4	64.5	54.9	52.5	58 0	53.5
13	50.4	51.5	47.9	38.	65.3	60.5	69.1	69.5	56.1	52.5	53.5	47.0
14	39.7	40.0	41.0	49.5	55.9	57.5	71.8	75.0	68.4	65.5	59.9	57.5
15	32.9	39.0	46.4	45.5	56.8	53.5	41.6	66.5	74.4	73.5	62.1	58.0
16	....	45.0	44.9	42.0	64.3	62.5	65.4	64.5	76.1	76.0	55.3	56.0
17	51.6	51.0	42.8	45.	70.6	70.5	70.3	64.0	73.3	74.5	52.7	51.5
18	42.1	35.5	47.4	45.	70.1	68.5	74.7	73.5	69.3	70.0	54.4	53.0
19	38.7	38.5	48.9	54.5	68.1	69.5	77.0	77.5	69.3	68.5	52.4	53.5
20	43.5	39.5	59.1	55.5	63.1	59.0	71.2	67.5	70.0	72.5	55.3	56.5
21	37.6	40.0	61.8	57.0	50.6	69.0	72.2	70.5	67.0	65.0	53.5	49.5
22	34.2	49.5	58.8	51.5	60.7	56.5	81.6	79.5	74.2	75.0	53.0	49.0
23	56.1	55.0	55.8	51.5	60.7	62.5	73.2	77.0	64.4	67.0	57.3	53.5
24	59.8	58.	57.1	58.5	64.3	61.5	70.9	70.0	65.7	65.0	52.2	57.5
25	51.3	55.	58.6	62.5	68.2	65.5	70.3	70.0	66.8	69.0	48.9	46.0
26	65.8	61.	65.4	67.5	70.6	70.0	66.6	69.0	66.8	73.5	52.5	52.5
27	60.4	62.	62.2	61.	66.7	69.5	70.9	70.0	63.5	64.0	54.4	58.5
28	45.5	48.5	60.2	47.	66.7	65.0	56.8	66.0	76.1	79.5	35.3	35.5
29	40.8	41.5	52.5	60.	69.6	73.0	58.8	56.5	66.4	64.5	41.9	32.
30	49.4	47.	60.7	58.5	73.6	75.0	66.1	63.0	69.0	62.5	38.2	42.5
31	....	....	58.2	59.	....	....	72.7	65.0	60.4	59.0		....
Mean..	42.3	41.1	52.2	54.0	63.8	63.8	68.6	68.4	67.7	67.3	55.1	52.2

An inspection of the above results shows but little difference between the calculated and the recorded temperature for the several months.

MEAN HOURLY TEMPERATURE BY MONTHS.

In the following table are given the mean average hourly temperature for each month from April to October as compiled from the records made by the self-recording thermometer for 1899.

A. M.	April	May	June	July	August	Sept.
1 o'clock	40.18	46.12	59.11	59.5	60.11	52.15
2 "	45.23	45.25	60.26	60.23	65.30	50.20
3 "	40.65	42.15	57.26	59.31	65.50	49.15
4 "	39.14	44.37	56.65	59.56	64.18	49.60
5 "	38.10	43.00	55.32	60.31	60.25	51.75
6 "	49.20	43.14	56.13	62.56	61.27	48.21
7 "	38.10	45.00	59.52	63.13	66.23	49.18
8 "	42.17	48.29	65.26	68.93	65.11	49.19
9 "	44.26	51.32	64.31	69.17	67.14	53.10
10 "	42.15	51.15	66.11	72.12	70.31	58 36
11 "	46.12	51.17	68.15	73.11	71.23	61.15
12 "	44.30	53.26	70.80	77.00	72.11	63.90
P. M.						
1 o'clock	47.11	58.72	71.80	77.10	73.11	66.16
2 "	48.38	59.00	71.60	78.10	75.31	68.20
3 "	45.24	59.13	71.26	79.20	74.18	68.17
4 "	53.13	57.27	71.48	79.52	74.25	66.44
5 "	49.68	56.10	70.13	78.22	74.77	67.12
6 "	48.12	57.10	69.14	76.3	72.12	66.17
7 "	47.21	57.15	67.32	73.11	67.17	62.16
8 "	35.10	51.00	62.31	71.43	68.42	59.00
9 "	43.11	51.75	60.32	70.14	69.15	56.40
10 "	42.15	46.21	62.50	65.15	65.37	54.21
11 "	41.13	48.16	59.50	60.12	62.18	56.93
12 "	40.10	45.11	58.31	62.20	61.25	52.14
Mean.....	42.26	52.21	63.76	68.59	67.70	57.12

Much work was required in compiling the temperature records for 1899 as given above, and it is believed the data will be helpful in understanding some phases of work now in progress at the station in plant growth, in relation to soil fertility and the available moisture.

SUGAR BEET EXPERIMENTS FOR 1900.

The sugar beet experiments in North Dakota for 1900 were almost a complete failure when compared with the results for previous years. When we consider the unusual season and the fact that the wheat and hay crop were the poorest in the history of the state we do not feel that the results do more than point out that an occasional poor year will occur.

Seeds were sent out to 325 farmers in all parts of the state. The season was so dry in the early summer that only forty-two farmers grew any beets whatever. In many instances farmers report that the ground was so dry that seed planted in May failed to germinate until the July rains came. The total snow and rainfall from January to July at Fargo was 6.96 inches. As the ground received but little moisture the preceding fall, there was not enough soil moisture to insure plant growth except when the land had been kept cultivated to conserve the soil moisture. In very few instances was this done with the small plots of ground where beets were to be grown. In early July beets that had started and withstood the drought began to make very rapid growth for during the four months, July, August, September and October the total rainfall was 18.26 inches, or only about one and one-half inches less than the average annual rainfall for Fargo for the previous nine years. The following table shows the rainfall and the per cent of cloudy weather for the several months.

	Inches	Per cent cloudy during day
April	1.82	36
May	.81	32
June	2.11	45
July	3.91	44
August	8.28	64
September	3.27	61
October	2.80	69

The last three months show a condition very unfavorable for the sugar formation and the results are, as might be expected, very low and not one of the forty-nine samples of beets sent in could be considered as mature. In a few instances the warm wet weather started a second growth with new top formation and lowered the sugar present as shown by earlier analysis. This is well shown in case of numbers 58 and 244.

ANALYSIS OF BEETS FOR 1900.

	Name	Post Office	Date Planted	Date Harvested	Average Weight	Per Cent Sucrose	Coefficient of Purity
1	M. J. Thompson	Calchutt	May 5	Sept. 21	1 lb. 3 oz	9.62	69
4	F. R. Rosenans	Anamoose	May 5	Sept. 26	2 lb. 1 oz	9.46	68
4	" "	"	May 5	Oct. 28	1 lb. 9 oz	11.60	68
10	M. C. Serpening	Larimore	May 10	Sept. 29	2 lb. 10 oz	8.62	67
10	" "	"	May 10	Oct. 16	2 lb. 3 oz	9.48	71
26	N. N. Fralick	Walhalla	April 15	Sept. 19	1 lb. 9 oz	8.14	64
26	" "	"	April 15	Oct. 18	1 lb. 0 oz	14.46	77
17	John J. Esstad	Hatton	May 25	Sept. 25	1 lb. 0 oz	10.58	74
17	" "	"	May 25	Oct. 13	1 lb. 13 oz	11.36	69
14	Emiel Wiese	Eldridge		Oct. 7	1 lb. 7 oz	10.72	68
18	John Ramsdell	Kenmare	May —	Oct. 20	1 lb. 4 oz	9.78	63
31	W. O. Wilson	Dunseith		Sept. 18	5 lb. 12 oz	3.60	
41	W. J. Beaver	Monango	May 13	Sept. 20	2 lb. 0 oz	6.44	
42	Thomas Hull	Fairmount	June 15	Oct. 18	2 lb. 9 oz	7.98	55
45	Stephen Donnelly	Grafton	May 5	Oct. 2	1 lb. 10 oz	8.94	80
48	C. W. Sherwin	Wimbledon	May 10	Sept. 19	0 lb. 6 oz	8.64	46
48	" "	"	May 10	Oct. 11	0 lb. 13 oz	12.16	70
58	James Greenwood	McLean	May 8	Oct. 8	1 lb. 2 oz	13.70	75
58	" "	"	May 8	Oct. 25	1 lb. 4 oz	11.80	74
67	Frank Duray	Warsaw	May 15	Oct. 8	2 lb. 3 oz	5.92	57
74	S. S. Keim	Kenmare	May 18	Oct. 2	1 lb. 5 oz	10.56	80
77	Henry Pruth	Stillwell	May 20	Sept. 20	1 lb. 8 oz	8.68	66
80	John N. Knackstedtt	Omemee	May 10	Sept. 29	1 lb. 9 oz	9.30	78
80	" "	"	May 10	Oct. 16	1 lb. 13 oz	12.56	78
83	Fred Jessel	McKenzie	May 2	Sept. 18	0 lb. 9 oz	10.24	69
83	" "	"	May 2	Oct. 19	1 lb. 0 oz	10.48	68
84	Wm. Perrin	Storlie	May 15	Sept. 29	1 lb. 15 oz	9.03	63
84	" "	"	May 15	Oct. 7	1 lb. 8 oz	13.12	67
84	" "	"	May 15	Oct 28	2 lb. 4 oz	13.44	72
95	F. A. Hughes	Maza	June 1	Oct. 3	1 lb. 9 oz	6.32	56
99	Adam Bennett	Scotia	June 10	Nov 9	1 lb. 0 oz	14.62	76
103	Jas. Mackie	Wyndmere	May 12	Sept. 17	1 lb. 12 oz	7.06	62
103	" "	"	May 12	Oct. 10	1 lb. 10 oz	8.22	62
111	T. J. McCully	Lisbon	May 10	Oct. 20	3 lb. 12 oz	10.92	71
118	Geo. T. Jager	Grinnell	May 24	Sept. 28	2 lb. 5 oz	10.02	68
112	B. Olson	Gilbert	May 20	Sept. 26	0 lb. 5 oz	11.68	73
264	David Finnie	Emerado	May 16	Sept. 21	0 lb. 14 oz	9.44	70
264	" "	"	May 16	Oct. 14	1 lb. 14 oz	12.04	74
309	L. A. Beaudoin	St. John	May 14	Sept. 25	0 lb. 15 oz	10.46	70
309	" "	"	May 14	Oct. 16	1 lb. 3 oz	11.22	67

ANALYSIS OF BEETS FOR 1900.—Continued.

	Name	Post Office	Date Planted	Date Harvested	Average Weight	Per Cent Sucrose	Coefficient of Purity
274	C. Nordvie	Georgetown	May 14	Oct. 2	2 ℔. 3 oz	8.02	63
295	Bernard Campbell	Buchanan	May 22	Oct. 2	2 ℔. 2 oz	9.56	72
295	" "	"	May 22	Oct. 29	1 ℔. 14 oz	9.24	70
244	C. B. Bovie	Jamestown	May 22	Oct. 1	1 ℔. 8 oz	9.28	69
244	" "	"	Apr. 27	Oct. 26	1 ℔. 15 oz	17.12	64
206	Wm. Watt	Leonard	Apr. 27	Sept. 29	1 ℔. 7 oz	12.50	73
306	" "	"	May 10	Nov. 5	2 ℔. 0 oz	12.98	76
	J. S. Kemp	Galesburg	May 10	Oct. 15	2 ℔. 9 oz	11.90	73
216	Judson Harrington	Jamestown	June 10	Oct. 20	1 ℔. 9 oz	11.66	71
	Peter Wickstrom	Lisbon	May 12	Sept. 24	2 ℔. 2 oz	4.96	50
227	"	"	May 12	Oct. 20	3 ℔. 3 oz	8.66	65
247	Joseph Jasper	Woodhull	May 10	Sept. 25	2 ℔. 2 oz	5.66	48
247	"	"	May 10	Oct. 19	1 ℔. 8 oz	9.18	64
264	K. J. Veum	Hoople	May 15	Sept. 27	1 ℔. 1 oz	10.28	72
265	Geo. Wesley	Fisher	May 20	Oct. 20	1 ℔. 2 oz	10.34	69
270	L. G. Wells	Lisbon	May 10	Sept. 29	1 ℔. 4 oz	10.27	71
270	"	"	May 10	Oct. 12	1 ℔. 4 oz	8.82	71
270	"	"	Nov. 1	Nov. 1	2 ℔. 4 oz	9 34	72

As in previous years the beet seed was furnished by the department of agriculture at Washington and the franking privilege for sending out the seed and for bringing in the beets was granted by the secretary of agriculture, thus making it possible for us to continue this line of work in the state.

Five varieties of beet seed were sent out and the tabulated results for the few samples of each variety sent in are as follows:

	No sample	Sucrose per cent.	Coefficient of purity
White Improved Vilmorin	26	9.80	69
Zehringen	6	9.53	64
Leicht's Kleinwanzlebener	3	10.87	71
Drippe Bros....	5	9.22	67
Russian	8	9.76	68

The average for the forty-nine samples analyzed was:

Per cent sucrose 9.81
Coefficient of Purity 65

The beets well cared for continued to form sugar quite rapidly as shown in case of number 26. Beets sampled September 19 gave 8.14 per cent of sugar and from the same plot those harvested October 18 or one month later contained 14.46 per cent. Number 84 for the three dates, September 29, October 7 and 28 gave the following per cents, 9.03, 13.12 and 13.44. An inspection of the tables will show the same general improvement, but the unfavorable season prevented maturity of the beets.

The repeated experiments of this station has demonstrated that North Dakota comes properly in the sugar beet belt and already capital has been attracted to the state for developing the industry. It is proposed to continue our sugar beet experiments for one year more in various parts of the state. After which it is proposed to study specific problems that will prove helpful to the farmers and manufacturers, should the industry become established in the state.

COMMERCIAL FERTILIZERS.

The first request for fertilizer analysis was made during the past year. Three samples were sent in by Mr. E. M. Upson of Cummings. Samples Nos. 2 and 3 were without name, while the first sample was the "Old Homestead" made in Detroit, Michigan. We find them to contain as follows:

	"Old Homestead"	No. 2	No. 3
Moisture..........................	13.34	7.41	9.23
Total Potash, K_2O................	2.11	0.56	0.28
Total Phosphoric and P_2O_5........	59.24	13.35	10.68
Total Nitrogen......................	2.19	3.02	2.21

Under proper methods of cultivation and crop rotation with a soil containing such quantities of phosphorus acid, potash and

nitrogen as is found in the valley soils, there should be no need for these fertilizers. It would seem from experiments already recorded that an equal amount of money expended in conserving soil moisture, in better methods of cultivation and in maintaining a high per cent of humus in the soil would give better returns than is received from applying commercial fertilizers.

CLAYS AND CEMENTS.

During the past year several analyses of clays and other mineral deposits have been made and a few of these may be of value.

Two samples from the Pembina mountains sent in by B. G. Skulason of Grand Forks showed the following results:

	"A"	"B"
Silicia $Si\,O_2$	12.72	25.43
Alumina $Al_2\,O_3$	5.27	10.72
Iron Oxide $Fe_2\,O_3$	2.51	3.60
Lime $Ca\,O$	40.72	28.39
Magnesia $Mg\,O$	1.62	1.23
Sulphuric Acid $S_2\,O_3$	3.15	3.90
Alkalies	Trace	Trace
Volatile matter	34.64	26.16
	100.63	99.43

The sample "A" might prove suitable as the bases for a Portland cement if found in sufficient quantity.

Sample of material No. 1 was sent from Medora by J. W. Foley. Sample No. 2 was sent in by A. M. Anderson taken from a large deposit about seven miles southwest of Northwood, while sample No. 3 sent by the same party was reported as taken from the Babcock mines in the Pembina mountains:

	1	2	3
Silica $Si\,O_2$	42.23	40.15	26.97
Alumina $Al_2\,O_3$	39.29	14.68	14.57
Iron $Fe_2\,O_3$	3.80	5.20	4.25
Lime $Ca\,O$	1.88	15.76	23.45
Magnesia $Mg\,O$	0.61	0.94	0.60
Sulphuric Acid $S\,O_3$	2.12	2.03	3.99
Alkalies	2.15	1.84	0.59
Volatile matter	8.86	18.51	26.51
	100.93	99.11	100.93

From the Pembina mountains near Walhalla several samples of clays were examined showing a content of lime CaO ranging

from 34.95 per cent to 39.12 per cent, the layer being about 10 feet in thickness under a fifteen foot drift deposit. Near the upper portion of the deposit was a layer designated as iron bearing material.

The following shows the analyses of two of the samples from these deposits; one the iron bearing and the other the clay.

	"Clay"	Iron Deposit
Silicia Si O_2	18.47	33.49
Iron Fe_2 O_4	7.27	4.10
Alumina Al_2 O_3	....	12.90
Lime Ca O	39.12	10.25
Magnesia Mg O	0.10	0.41
Sulphuric Acid S O_3	Trace	15.22
Alkalies	Trace	0.61
Volatile matter	34.37	22.23
	99.13	99.21

The first, it is thought, would be suitable for manufacturing cement, while the deposit designated as "iron deposit" might serve as the bases for a mineral paint.

Four samples of clays were sent in from Gardar, taken in a ravine, between 300 and 400 feet deep. Sample No. 1 taken about thirty feet from the bottom. A thin layer, No. 2, overlying No. 1 about twenty feet thick. No. 3 samples from a 6-inch layer overlying No. 2. No. 4 a 4 to 6-inch layer of dark material just above the others:

	Samples Numbers.			
	1	2	3	4
Silica Si O_2	52.22	58.88	58.90	71.10
Alumina Al_2 O_3	18.26	15.40	22.97	12.88
Iron Fe_2 O_3	8.70	5.60	1.12	2.62
Alkalies	2.40	2.40	0.66	1.26
Lime Ca O	trace	trace	trace	trace
Magnesia Mg O	trace	trace	trace	trace
Sulphuric Acid S O_3	30.52	0.68	0.50	0.29
Volatile matter	18.78	17.66	15.62	12.95
	100.88	100.62	99.77	101.10

Sample No. 3 above is not so very different from some analyses of the Stourbridge clays of England.

A sample of clay No. 1 in the following table was from a deposit near Langdon sent in by James Trennum.

Sample No. 2 was sent in from Lisbon by J. L. Brown.

Sample No. 3 taken from a bluff near Hebron which forms a 20 foot layer with three feet of overlying yellowish clay.

The results are shown in the following:

	Sample Numbered		
	1	2	3
Silica $Si\,O_2$	70.00	16.35	79.55
Alumina $Al_2\,O_3$	17.19	6.12	14.26
Potash $K_2\,O$	trace	trace	0.61
Soda $Na_2\,O$	trace	trace	trace
Lime $Ca\,O$	0.90	24.30	trace
Magnesia $Mg\,O$	0.85	0.48	trace
Iron $Fe_2\,O_3$	3.47	1.68	0.84
Volatile matter	5.00	35.79	4.54
Sulphuric acid $S\,O_3$	3.07	15.92	trace
	100.48	100.64	99.80

Sample No. 3 above is very similar in composition to some of the clays used so extensively as fire clay in the New Jersey industries.

Sample No. 1 from Langdon is of a similar kind but contains more iron and in addition sulfates.

LIME ROCK.

Deposits of lime rock suitable for burning for lime, so far as I am aware are not found in the state. Frequently specimens, mostly boulders or drift rock, are sent in for analyses. The following, one from Oakes in the south part of the state, and the other from the Pembina mountains in the north part of the state, shows about the average composition for these rocks:

	Oakes	Pembina Mountain
Silica $Si\,O_3$	trace	19.70
Lime Carbonate $Ca\,C\,O_3$	52.17	75.32
Magnesia Carbonate $Mg\,C\,O_3$	46.10	4.98
	98.27	100.00

SOIL INVESTIGATIONS.

The work in soil analysis and soil investigation regarding available plant food and soil moisture in relation to the organic matter and humus has been continued during the year. Much

data in regard to nitrates and nitrites are now ready for publication as a part of a forthcoming bulletin. Some studies of composted manures have furnished interesting data to be used in the same connection.

BROME GRASS.

During the past summer Adele Shepperd conducted an experiment to determine the relative yield and comparative value of timothy and Brome grass for hay and for pasturage. The season emphasized the value of brome grass in dry seasons or regions of low rainfall under conditions of soil and climate such as exist at Fargo. The full results will be published as a part of a forthcoming bulletin. In the experiment the field work was looked after by Professor Shepperd.

ASSISTANCE AND NEEDS.

During the past year Mr. Hugh McGuigan has been the assistant in the station laboratory and much of the analytical work has been done by him in a most satisfactory manner. The great need of this department at the present time is more space and rooms adapted to conducting research work, and I trust this condition may be remedied during the present year. We shall then be able to undertake other lines of work that should give results helpful in developing the agriculture and manufacturing industries of the state.

Respectfully submitted,

E. F. LADD,

Chemist.

DEPARTMENT OF BOTANY.

To Director J. H. Worst:

Sir: The lines of work in this department have been chiefly concerned with studies upon wheat, potatoes, flax, weeds and the native plants of the state. In general the studies are continuations of work undertaken in previous years.

WORK WITH WHEAT IN 1900.

Selection of wheat from the industrial head: Continuing the work of 1899 and of previous years and using the heads which were saved from 1899, plantings were made from twenty-one different lines of pedigrees representing forty-two individual heads. These heads were the best heads which could be selected from the crop as grown in 1899, one good head being selected from the best stool which grew from the largest grain found in the head which was grown in 1898, and one from the best stool which was grown in 1899 from the smallest grain selected from the head which was grown in 1898. The grains were planted in soil of good, even quality which had not received fertilizer for a number of years, in beds just large enough to allow six plants to grow in a row across the bed. From the selected heads there were taken six of the largest No. 1 hard-grains and six of the smallest grains that could be selected, which yet remained perfect in form. The plants having been pulled in 1899, and cured in the laboratory were good and dry, hence all mature grains showed good color and form and were in good viable condition. It is easy under such conditions to select from a good mature head six large grains and six small ones which are perfect in form but very different in size. This year the large grains selected were almost always over twice the weight of the small ones selected. Each set of six grains was planted to an equal depth in a well prepared bed side by side, the rows being a foot apart, and the grains four inches apart, in the row. All were planted about one and one-half inches deep. At harvest time, July 25th, each stool was pulled, as in previous years, the roots dusted and the grain allowed to thoroughly ripen and cure in the straw as it stood in a well lighted airy room. September 10th records were taken upon the number of stools harvested for each planting, the number of straws, the total weight of stools, grain and straw, and the total length of the best straw in each case. Some of the

samples were photographed for records, and previous to planting in 1901 the total number of spikelets and grains of each selected head will be recorded, together with the total weight of the grains in each head. Though the details of this sort of experimental work accumulate very rapidly we hope to continue the experiment for a number of years, recording the data gained. There are already many pages of these records which will need to be compiled in a separate publication to give an idea of the results attained. A number of years records carefully kept will, we believe, allow one to draw a number of very definite conclusions regarding the proper methods of selecting grain with reference to the improvement of a variety. The details of the experiment are too extended for publication in this report. Suffice it to say that it is quite surprising how important the matter of pedigree or strain shows itself to be in regard to this important question. Though the year was very unfavorable for the growth of cereals, we succeeded in producing from these selected grains quite a perfect crop. During no time of the growing season was one able to distinguish between the growth from the large seed and that from the small seed from the same head. It is very noticeable that there was differences in the growth from the seeds from different stools, even in this close line of selection, which has been followed for three seasons, starting originally with what purported to be pure varieties of Scotch Fife and Blue Stem.

The actual record of all the different features of growth will probably show an advantage in favor of the large seed as against the small from the same head, but the statement which I think I am safe in making from a general survey of the work for three years, is that the quality of the individual grain as to viability is of very much more importance to the general farmer than the consideration of size; that is, it would be preferable to take a small grain of perfect quality rather than a much larger one from the same head, if slightly injured.

The following rough summaries upon some of the points of comparison will perhaps indicate about the variations which may be expected throughout the different comparisons which may be made between the small and the large seeds from the same head.

Length of straw produced: Out of thirty-four stools the number of times the best length of straw was in favor of the large grain was fifteen. The number of times the best length of straw was in favor of the small grain was ten, and the number of times in which the best length from the small grain was equal to the best length from the large grain was nine. This shows a margin of five times in which the greatest length was in favor of the large seed.

Total weight of straw and grain: The number of pairs considered was eighteen.

The number of times which the total weight from the large grain exceeded the total weight of product from the small grain was eleven.

The number of times which the total weight of the products from the small grains exceeded the total weight of the products from the large grains was seven.

The total weight, in grams, of straw and grain from eighteen rows from big grains was 1,417, there being 102 stools.

The total weight, in grams, of the product from eighteen rows or 102 stools from the small grains was 1,328 grams.

These points of comparison all show a slight advantage in favor of the product from the large seed, leading to the conclusion that even though not noticeable in the field as the crop is growing, the advantage is nevertheless in favor of the big seed. This would indicate that even though a seed sample is all of the same line of descent or pedigree, it would be an advantage to grade out the small grains, if the best crop is desired.

Selection of wheat from the bin, and comparison of the value of large and small grains of wheat for seed purposes: This is the third year in which this line of work has been carried on. The experiment conducted in 1900 was as follows:

From a thoroughly well graded sample of Scotch Fife wheat there were selected eight hundred of the largest, plumpest, finest colored grains. From the same sample there were selected eight hundred of the smallest possible grains which were plump, hard and of similar fine quality. The weight of the eight hundred large grains equaled twenty-three and one half grams. The weight of the eight hundred small selected seeds was twelve and one-half grams, thus the same number of large grains weighed almost twice as much as the small grains. Each sample was seeded in a nicely prepared bed side by side in rows, so that the grains were approximately one and one-half inches apart in the rows. The bed, as in the case of the last experiment was surrounded by a double row of speltz to form a protection from the weather, and allow each plant of the selected seed wheat to have as nearly an equal chance with the others as possible. The grains were planted on the date of April 17th and all were up nicely by May 5th. The growth was not so even as that represented by the hand picked grains from the same heads. It was very noticeable that some stools were short and some were long, although they appeared to have equal chance. Both beds were harvested on July 24th by pulling. The roots were dusted and the crop allowed to mature as a whole in a dry room.

The following comparisons may be drawn: The total weight

of the straw and grains produced from eight hundred grains was six thousand eight hundred and fifty-seven grams.

The total weight of straw and grain produced from eight hundred small grains was six thousand two hundred and six grams, leaving an advantage in favor of the product from the large grains of 651 grams, or a gain of over 10.4, 10 per cent in favor of the product from the large grains.

Comparison No. 2: The dried heads were clipped from the straw close to the head in each case. The total weight of heads from the 800 large grains was 2,482 grams. The total weight of heads from 800 small grains was 2,203 grams, leaving a difference of 279 grams or about 12 6-10 per cent advantage in favor of the large seed. This shows quite a marked gain in favor of the large seed in this sort of selection. It demonstrates quite clearly that the small grains from the bin are not of as good value as the large ones, even though the small grains were selected with great care in regard to their physical qualities. It is a good evidence in favor of the recommendation that before sowing any sample of seed it will be of advantage to grade out the grains of small size. As, in this selection, all the grains selected were of the finest quality, the evidence is of all the more importance, as in case of injury, the small grain could certainly not have any advantage over the large grain. There also appear to be plants within a variety which tend to produce plants of a small type.

The growth of wheat from immature seed: The department has again made a test upon the growth of wheat from different grades of immature wheat. In order that the test might be as accurate as possible the grain was cut at different stages of maturity during the harvest of '99, even cuttings being made from the same plot of Scotch Fife wheat. In order that the samples might be under as equal conditions of harvesting and curing as possible, the heads of each sample were cut off from the straw just ten inches below the head. The bunches were cured in a dry room and kept in the straw until the date of seeding in 1900.

Sample No. 1: The first cutting was made July 28th, 1899, when the grain was very immature, hardly in the milk stage. When cured the grains were very much shrivelled.

Sample No. 2 was cut August 2 when the grains were just in the milk stage.

Sample No. 3 was cut August 10th, when the grains were just approaching the dough stage.

Sample No. 4 was cut August 17th when the grains were near maturity, slightly past the dough stage.

Sample No. 5 was cut August 28th, one month after the first sample was cut, the grain at this time being dead ripe.

The different samples were threshed April 11, 1900, and every sample tested in a Geneva germinator at the room temperature.

Each sample gave 100 per cent of germination, that is, all of the grains grew. The peculiarity of the germination was that the most rapid growth from the first was made by the most immature samples, that is: the properly cured immature grain will germinate more speedily than thoroughly matured grain of the same strain. There was a marked difference in the strength of the germination, the sprouts from the immature grain being many times longer at the end of the germination test than those from the mature wheat, while the latter were three to four times as strong in cross diameter. All were planted under what were supposed to be equal conditions on the date of April 12th. April 24th all plants were nicely up, the plants from the immature seed growing out of the ground a little quicker than those from the more mature ones. From the start the grains from the most mature samples produced plants of stronger, steadier growth. The season was very dry and after six weeks' growth it was very evident that the plants from the two most mature samples were very much the strongest. The first rain, however, due to an accident of the ground, gave the advantage of moisture to rows No. 1 and 2 which grew nearest the road ditch some six feet away. Though the rains were light during the season the ditch accumulated enough moisture to give the immature seed very much the advantage with reference to obtainable moisture. At harvest time the crop was very apparently better from the immature than from the mature seed. Thus no conclusions can be drawn from the experiment, except from the observations made upon the first growths. There is, however, a lesson in regard to farming methods to be drawn from the experiment. Preparation of the soil and good seed each have much influence upon the growth of a crop. Because one may procure a fine crop of grain from a poor quality of grain or seed one year, it should not be supposed that such seed is to be relied upon under all conditions. Under equal conditions this experiment could have shown but one point, viz: the great superiority of the properly matured plump grains.

Work in stinking smut of wheat in 1900: The following observations were made upon the growth of stinking smut (Tilletia) of wheat, to determine the question of whether smut winters over in the ground so as to produce a large amount of smut in the following crop, to observe the effect of weather and soil conditions upon the development of smut in the crop and the effect of the depth of planting.

Experiment No. 1: To test the wintering of smut in the ground. A plot of ground was selected upon which a large crop of smut was raised in 1899. The wheat in that year was very smutty, showing 47 per cent of smutted heads in the product. The grain upon this plot was allowed to thoroughly ripen. One

portion of the crop was harvested by a binder and the bundles removed, as is done in the ordinary farm methods. On the other half of the plot the grain was allowed to fall to the ground without being harvested. In the fall the stubble ground was plowed, also a portion of the unharvested crop was plowed under. On April 12th half of the remaining ground was plowed in the usual manner. The remainder was disked by means of an ordinary disk harrow.

On April 12th, the same day of the spring plowing, five plots were laid out across this ground, so that each plot would run across these differently treated pieces of land, and the plots were then seeded as follows:

No. 1 to untreated wheat selected from the agricultural college bins.

Plot No. 2 was seeded to the same sort of wheat which had been treated in the standard formaldehyde solution as used for the prevention of smut (one pound to forty-five gallons of water.)

Plot No. 3 was seeded to the same sort of wheat which was treated for fifteen minutes in hot water at 133 degrees Fahrenheit.

Plot No. 4, same grain as last, treated after the same manner and afterwards dusted or smutted with smut spores which were raised in 1898. The powdered smut used was thus two years old.

Plot No. 5 was seeded to similarly treated grain, in which the smut used was one year old. The smut in each case had been kept in the balls open to the action of the air, at ordinary room temperature in the laboratory.

It was possible from this experiment to learn a number of points with regard to the growth of smut. The plots showed the following results in the development of smut at harvest time.

Plot No. 1 by actual count of the heads to the extent of 1,000 showed the following per centages of smut:

Smut on the disked portion of the plot	.3 per cent
Smut on the fall plowed stubble portion of the plot	1.0 per cent
Smut on the spring plowed, straw lodged portion of plot	.9 per cent

PLOT NO. 2.

Smut on the disked portion of the plot	.0 per cent
Smut on the fall plowed stubble portion of the plot	.1 per cent
Smut on the spring plowed, straw lodged portion of plot	.1 per cent

PLOT NO. 3.

Smut on the disked portion of the plot	.3 per cent

Smut on the fall plowed stubble portion of the plot .3 per cent
Smut on the spring plowed, straw lodged portion of the plot .... .1 per cent

PLOT NO. 4.

Smut on the disked portion of the plot .... 12.6 per cent
Smut on the fall plowed stubble portion of the plot 21.0 per cent
Smut on the spring plowed straw lodged portion of the plot .... 21.0 per cent

PLOT NO. 5.

Smut on the disked portion of the plot .... 17.9 per cent
Smut on the fall plowed stubble portion of plot.. 34.0 per cent
Smut on the spring plowed straw lodged portion of plot .... 47.4 per cent

It is very plain that though a very large amount of smut must have fallen to the ground upon the straw lodged portion of each of these plots in 1899, yet there was not a marked gain of the amount of smut produced in 1900, either upon plowed land or upon disked land.

Studies of the smut balls found on the ground at seeding time in 1900, showed that the smut spores in these balls retained their viability when placed in the germinator they made good growths. No explanation can therefore be made of the lack of increase of smut in the crop in the presence of this abundance of smut, which had fallen to the ground, except that the spores failed to get distributed that any number of them might come in direct contact with the young wheat as it was coming out of the ground. A small amount of smut grew upon all of the plots. It is in those plots that some smut may originate in a crop from smut balls which fall to the ground during the previous harvest, but it is again demonstrated as I have done in a number of previous tests that the amount of smut which may originate this way is so slight as to be of no economic importance in a general crop. This will especially be true because in ordinary methods of harvesting nearly all of the smut balls are removed by the removal of the unthreshed grain from the field.

Smut which is two years old has not lost its capability to produce smut in a crop, if the wheat has been stored in the ordinary manner, thus those who have smutty wheat over one year old must expect to treat it the same as they would if it were only one year old. See for example the results obtained in plots 4 and 5 of this experiment. The one year old smut produced more smut in the crop than the two year old, but I was able to produce 21 per cent of smutted heads by the use of the two year old smut spores in the infection test.

The Influence of Smut Upon the Doughing of Flour and Bread Making: The statement is usually made that stinking smut injures the rising qualities of bread making the dough stringy and irregular in its rising qualities, usually with a tendency to run. With the view of ascertaining the influence of the smut spores upon the baking qualities of flour, a number of tests were made. Tests were also made to determine what caused the darkening effect upon dough and the baked product.

The following is a short summary of the work done. A good sample of flour of the brand of Fargo's Best was selected and 8 1-2 ounce loaves of bread were baked from it.

The loaves of bread were made as follows:

Flour, one even cupful.

Pure smut spores, screened from pulverized smut balls, two tablespoonsful.

Sugar, two teaspoonsful.

Salt, one teaspoonful.

Lard, one teaspoonful.

Potato yeast, one tablespoonful.

Water, one cupful or to proper consistency.

Set to rise.

A number of other loaves were made in which varying quantities of the smut were placed, some in larger amounts and some in less than in this example. Other loaves were baked by the same recipe without smut at the same time, for check or comparison.

To summarize the results, the flour containing the smut spores acted no differently, except in being colored, from that which did not contain the smut spores. It was properly raised in the same length of time, the action of the dough not being noticeably different. When baked the characteristic shape and form of the loaves and the texture was not noticeably different, except for the color due to the presence of the smut spores in the smutted sample. When cut fresh there was not enough smut to give any perceptible difference in odor. When tested there was not enough smut present to give any perceptibly different taste. In color, however, the loaf was almost black when two tablespoonfuls of smut was added to the flour, so black that no one would think of eating it. The conclusions to be drawn from a number of these tests leave no chance for doubt. The smut spores, of themselves, have no effect upon the doughing and baking qualities of the flour.

It is a matter of interest whether the color was due to the actual presence of the spores or whether the coloring matter was solubly.

Microscopic examinations of bread showed two points. The smut spores kept their original cellular form and essential struc-

ture. They remained of normal color and there was no apparent coloring of the surrounding starch and dough or bread substance. Thus it was found that the coloring matter of smut spores is not soluble in the ordinary process of making bread. Later tests show that the color does not come out by the action of water or alcohol, and microscopic examination of flour samples containing smut showed that practically all of the smut spores go through the milling process unchanged in form, that is, the spores are sufficiently minute to escape the crushing action of the rollers.

The conclusion to be drawn concerning the color of smutty flour and bread is thus quite plain. It is due to the actual presence of the smut spores and not to any coloring matter which is dissolved or thrown off from them.

The Effect of Soil and Weather Conditions Upon the Development of Stinking Smut in Wheat: A number of observations upon the influence of weather and soil conditions upon the development of smut in a smut infected crop were made during the year, continuing the observations of previous years. Although the season of growth was one of almost complete drouth, showing for the months of May and June a total rainfall of less than three inches upon an already dry soil, yet the growth of smut in the ordinary planted crop of wheat was quite abundant.

Examination of numerous threshed products from all parts of the state show that this has been true throughout the state. Full as high, or even a higher percentage of smut has evidently been produced in many fields of the state as in the ordinary season. One discovery was made which is of interest as a matter of record here. In previous years I have demonstrated (see Bulletin No. 37,) that the greatest amount of smut would be produced when the soil conditions were the best possible for the growth of wheat from the seed. It was clearly shown that soil which was very wet, though not too wet to develop a reasonable crop of wheat was unfavorable to the development of smut. The very dry conditions of this year show by the experiments made, that though wheat may grow to a reasonable crop a very dry soil at and just following the germination period is unfavorable to the growth of smut.

A number of tests were made and the following table will quite clearly illustrate the point:

A TABLE SHOWING THE EFFECT OF DIFFERENT DEPTHS OF SEEDING IN A DRY SOIL UPON THE DEVELOPMENT OF SMUT IN THE WHEAT CROP.

Plot No.	Date of seeding and condition of seed	Depth of seeding	Per cent of smutted heads in the crop
6	April 17, very smutty; formaldehyde treated	¼ plot 3 inches deep ½ plot 1 inch deep	
7	April 17, same wheat untreated	½ plot 4 inches deep ½ plot ¾ inch deep	53 4
8	April 21, Speltz thoroughly soaked in wheat smut	2 inches deep	
9	April 23, same wheat as 7, untreated	½ plot 3 inches deep ½ plot 1 inch deep	21 1½
10	April 24, same wheat treated in formaldehyde	2½ inches deep	
11	April 24, same seed untreated	1½ inches	9
12	May 3, same wheat untreated	½ plot 4 inches deep ½ plot 1 inch deep	40 21
13	May 24, same wheat treated in formaldehyde	1 inch deep	
14	May 24, same wheat	1 inch deep	10
16	June 2, same wheat; formaldehyde treated	3 inches deep	....Poor crop
17	June 2, same wheat untreated	3 inches deep	5—Poor crop

Summary: It is to be noticed that the formaldehyde treated samples did not produce any smut, no matter on what date they were seeded, or at what depth. The samples which were untreated produced a high percentage of smut when planted deep, as for example, in plots 7, 9 and 12, but when planted at a very shallow depth as in one half of plot 7, one half of plot 9, very little smut was produced in the crop. In plot 12 one half was planted four inches deep and showed 40 per cent of smut, one half was planted one inch deep and showed 21 per cent of smut. During all the period of planting time covered by these different experiments the beds upon which the samples were planted were in very fine garden condition, but the top soil was very loose and dry, so that grain planted less than an inch deep was in almost a dust bed, showing very little signs of moisture, while the grain which was planted over two inches deep lay in the ground, which was in good condition for germination.

The explanation of the effect of deep and shallow planting in the case of these plots seems to be that smut demands an atmospheric condition in the soil, which approaches saturation in order to give the best germination of the spores. When the wheat was planted at a depth of less than one inch, it got sufficient moisture to germinate but the smut spores did not, thus the deep planting was favorable to the production of smut. Another reason for there being more smut in the deep planted than in the shallow would be, in the fact, that it takes the young wheat plant a longer time to get out of the ground and develop that hardness of skin which prevents smut infection.

The practical point for farmers to remember is that some smut was produced even in the shallowest planting, and that plenty of it was produced when the wheat was put down an inch deep. In sowing wheat on a farming basis, it will not be practicable to take into consideration depth of seeding when trying to avoid smut; for an ordinary depth of drilling will put the grain deep enough for it to get the best possible amount of moisture, and yet not have it too deep for good growth. This depth will be found to furnish plenty of moisture to germinate smut spores.

An interesting point in connection with observations made upon these experiments was the point that when wheat was properly covered in a properly prepared seed bed, even during the past dry seasosn, the shallowest planting, viz: one-half inch to one inch deep, always came up quicker and stronger, made a better growth throughout the season than wheat which was planted at depths greater than two inches. Wheat which was actually put down four inches almost failed to come up, being over a week later than that which was an inch deep, and when it did come was weak and spindling and never made a strong growth during the season.

Note: It is probable that wheat which is actually seeded to a depth of one inch to one and one-half inches will make the best growth. There seems to be a depth which is somewhere in the neighborhood of one inch, at which it is not necessary for the wheat plant to send out a joint (node) before the permanent root formation and stooling takes place. When wheat is planted deeper than an inch, say two to three inches, it first sends up a small stem, forms a joint within about half an inch of the surface and from this joint sends out a new set of roots, the original roots down next to the seed dying. There is barely nutriment enough in a grain of wheat to make this first joint develop to a length of two and one-half to three inches without detriment.

The observation teaches that it is desirable to prepare a good even seed bed, so that the grain may be covered to a uniform depth of not to exceed two inches.

Selections of Wheat to Avoid Rust: An attempt was made during the growing season to select some plants from definite varieties which showed some marked capability of resistance to rusts. The dry season was very unfavorable to the development of rust and also of characteristic wheat plants. From a large number of observed plants I was unable to make any selection which gave promise of being more immune from rust than other plants.

THE WORK WITH POTATOES DURING THE SUMMER OF 1899.

The Selection of Potatoes From the Bin in an Attempt to Breed to Desired Shape of Tuber: During the work upon the selection of potatoes for seed and the study of the growth of potatoes from large and small tubers from the same vine or hill for the years 1894, 1895, 1896, 1897, 1898 and 1899, it was demonstrated that the matter of vine pedigree was a very important one. It was found that by selecting potatoes from the vine in the hill at digging time one could breed almost any desired form within the range of the usual shape of the variety, the strains breeding very true to the lines of selection. The work this year was an attempt to see if the knowledge gained was sufficient to allow one to select from a large bin of a given variety, potatoes of a certain shape, so that the majority of the hills would tend to reproduce that type of tuber. Twenty-one different plots were planted, using the best hand selected tubers obtainable. Four varieties were used in the test, Sunlit Star, Dakota Seeding, Trumbull and Early Ohio. The largest, best and nearly round tubers were selected from each variety, also the largest, best, typical long shaped tubers were selected from each variety. In the case of the Early Ohio a third selection was made of the largest, most irregular shaped tubers. These were planted upon an even quality of seed bed at an equal depth, each tuber being cut in two pieces of equal weight and placed surface down at a depth of six inches, and records were made upon all of the hills at digging time with regard to the prevailing shape of the tubers in each hill.

The following statements may be made from the work. No great success may be hoped for in selecting after this manner from the bin. On the average, a larger number of the hills tended to produce potatoes similar in shape to the patent tuber than tended to vary from it in the opposite direction from the selection. Thus, in hills from seed tubers selected because of their long oval shape, the general tendency was to produce tubers of the long oval shape, as shown by a summary of all the examinations made, several hundred hills in all. But in many cases tubers which were selected because of their long shape produced typical round tubers. The work emphasizes the fact that if one wishes to breed a certain form and quality of tuber, he must make the selection in the field from the vine, as previously demonstrated in Bulletin No. 30 of this station. It does show, however, that it is best to select from the bin the shape desired rather than to make no selection at all.

In the plots in which tubers of the Early Ohio variety were selected because of the large knob-shaped outgrowths upon

them, it was found that there was no apparent tendency to reproduce such knobs in the good even quality of soil which observation seems to bear out those made in previous years, that such outgrowths, especially upon the Early Ohio variety are due to bad mechanical and physical conditions of the soil.

The Comparison of the Value of the Stem and Bud or Tip End of Potato Tuber for Planting Purposes: The experiment station workers have made a very great number of tests upon this question. The work upon potato selection has allowed me to make observations upon this point, which I think constitute a better basis for conclusions than any experiments previously made, with which I am acquainted.

In making the studies upon selection I have attempted to use potatoes of approximately equal weight and equal weight of seed piece per hill, and have been particularly careful that the ground should be of equal quality of fertility and in equal mechanical condition. Have planted all comparative plots at same depth and have been very careful that they should have equal cultivation per hill. This year an opportunity was given to contrast the stem and tip end of each tuber. Tubers of approximately equal weight exceeding ten ounces were cut in halves diagonally, so that while the weight of each piece remained approximately the same. All of the eyes which are characteristically tip or "seed end" eyes remain upon the tip piece.

Each piece was planted cut surface down, six inches deep and four feet apart each way.

Very little difference was noticed in the growth throughout the season. All hills were hoed upon the same day and in the same manner and kept free from bugs and disease by proper methods of treatment. The crop made a very fine growth, so that the yield was very close to three pounds per hill on the average. At digging time, October 11th, when all hills were thoroughly matured the following records were taken: The typical shape of the tubers, the number of tubers, the number of stalks and the total weight of tubers in each hill.

The tip piece and stem piece of each parent tuber were planted in adjacent hills and made a very strong even growth throughout the season. The only noticeable difference was in the observation that the plants from the tip piece got out of the ground on the average a little sooner than those from the stem pieces. Before planting, the potatoes were in good condition, never having developed any sprouts and were treated with formaldehyde to prevent growth of scab.

The summary of results as tabulated is too extended for record here.

The following summary made from that table will indicate the general trend of the results.

First, the tubers in the hills raised from the tip and stem end of the same parent tuber have a general tendency to resemble each other in form, size and quality.

The hills from different parent tubers, even in the same variety, may produce tubers which vary from each other considerably in shape, texture of skin, size, etc.

The number of stalks and tubers produced from the complimentary pieces of one parent tuber showed a general tendency to equal each other, that is, they are more nearly of the same number than those found in hills which come from different parent tubers.

There was considerable variation in the number of stalks produced per hill by the tip and stem ends of the tubers. The number of times the stalks from the tip piece exceeded the stalks from the stem piece was 31.

The number of times the stalks from the stem piece exceeded the stalks from the tip piece, 29.

The number of times the stalks from the tip piece equalled the number of stalks from the stem piece was 28.

Total number of hills considered, 88.

The average number of stalks from hills from tip piece, 4.8.

The average number of stalks from hills from the stem piece, 5.2.

Comparison of number of tubers per hill—total number of hills considered, 87.

The number of times the tubers in hills from the tip pieces exceeded in number the tubers in hills from the stem pieces, 42.0.

The number of times the tubers from the stem piece exceeded the number of tubers from the tip piece, 35.

The number of times the tubers in the complimentary hills were equal was 10.

Average number of tubers, per hill, from the tip pieces, 14.8.

Average number of tubers, per hill, from stem pieces, 14.3.

The weight, per hill, contrasted—the number of complimentary pairs of hills considered, 55.

The number of times which the product per hill, from the tip piece exceeded in weight the product from the stem piece, 37.

The number of times which the product, per hill, from the stem pieces exceeded in weight the product from the tip pieces, 17.

The number of times which the products were equal in weight, per hill, 1.

Average weight of the tubers, per hill, from tip pieces, 47 oz.

Average weight of the tubers, per hill, from the stem pieces, 44 oz.

From these three comparisons it is seen in each case, with the

exception of the average number of stalks per hill, that the tendency of crop production is slightly in favor of the seed end piece. It was so slight, however, that no one could have noticed the difference as the crop was dug in the field, except that these records had been taken. I am inclined to think that with good sound selected, unsprouted seed tubers the difference in favor of the seed end, if any really exists, will be found to be so slight in ordinary methods of farm practice that it need not be taken into consideration.

I think the slight difference noticed in this experiment in favor of the hills grown from the seed end was really due to the fact that the early portion of the season just following planting time was abnormally dry. Under these conditions the seed end pieces seem to have had a slight advantage in the early period of growth in that they germinate a little more rapidly and thus got a slight advantage of start over the stem pieces, which was an advantage to them because of the long period of drouth immediately following:

Root-fusion in Potatoes: The study of the question as to whether the roots of potatoes fuse in the soil and tend to bring about a crossing of varieties when growing side by side is an interesting one. It has often been claimed by farmers that potatoes will "mix in the hill" where different varieties are grown close to one another. I have thought that one of the ways in which this could occur, if it ever really does occur, would be through the fusion or union of the living roots which come in contact with each other, thus acting like grafts one upon another. In the year 1899 a small test of this was made in the green house, a number of tubers of different varieties being planted very closely together, so that the roots would become thoroughly entangled. These roots were washed and studied, but no evidence of root fusion was observed. During the present year two experiments were carried out, one in the green house and one in the field. The two varieties selected for experiment were Early Trumbull and Dakota Seedling, one a rather white potato producing greenish buds at the first growth from the eyes, and the other a pink skinned, deep eyed tuber producing dark pink buds or sprouts on the first growth from the tuber. It was thought that these two marked varieties would be good ones because of these color and skin characteristics. In order to place the young plants from each variety in as close relationship to each other in the hill as possible. Tubers of approximately the same shape and size were selected and cut longitudinally in halves. One-half from each variety of tuber was matched with a half from the other variety immediately while the cut surfaces were fresh. They were then bound together very tightly so that it would be possible for the cambium area of each half tuber to

fuse with that of the other if such a phenomenon could occur. One set of these tubers was planted in the green house in pots and the plants examined from time to time. There was no indication of root fusion observed from these plants. In the case of hills which were allowed to mature there were apparently typical tubers of each variety in each pot, but no tubers which showed an apparent mingling of the strains.

Fifty-seven hills, the seed tubers of which were prepared in a like manner, were planted in the field. These were allowed to grow to maturity and the products when dug were carefully considered to see if there were any indications of tubers which bore characters of two varieties. None were found which seemed in any way to be crosses. A number of the most likely in shape and color of skin were saved, washed, and laid away to sprout. The sprouts from these each showed in every case a typical characteristic of the parent variety, with no indications of crossing. The work will be continued another year in a still more careful manner, but so far as the two varieties are concerned there seems to be no indication that the roots or any part of the living plants will unite.

STUDIES UPON FLAX IN 1900.

Cause of Uneven Ripening of Flax: For a number of years the farmers in different parts of the state have complained of cases in which their flax crops have failed to ripen evenly, some saying that the same seed was used yet, on different pieces of ground, the results were wholly different, others that when seeded on different dates upon the same type of ground results were sometimes even ripening and sometimes uneven. After observing this feature of the flax crop for several years, it seemed that it was one worthy of consideration at the experiment station. A crop of flax which ripens evenly is, other things being equal, a paying one, because it can be harvested and cured easily, giving an even grade of seed. On the other hand a crop which has some ripe bolls, some green ones and some flowers gives a crop which the farmer does not know when to cut, and whenever he does harvest, it will result in a grade of seed of inferior quality. Besides there will often be a considerable loss from the shelling of the thorough matured bolls, and from injury in curing, due to green flax.

In order to study this question a piece of ground was prepared very evenly throughout all its parts and was selected because of its even quality with regard to fertility, physical condition, etc. Several supposed varieties of flax seed and several different grades of one variety as to quality of seed were selected to be used. These were contrasted by growing them upon the selected plot of soil in a number of different ways, sometimes, all

planted on the same day at the same depth, sometimes planted at very different depths. Plantings were made on April 12th and 24th, May 3rd, 10th, 17th, 23rd and 24th, June 1st, 6th, 12th, 21st and 27th and July 4th. The different depths of planting ranged from one-half inch to four inches deep. The even character of the growing season from the date of the first planting, it being one of almost constant drouth allowed of a very good judgment to be made as to the number of the causes which may produce uneven ripening in the crop.

The results of the observations from the growth of all of the different plots may be summarized as follows:

The irregular ripening of flax may be due to a large number of causes, the most prominent of which are the following:

1. Irregular Quality of the Seed Used. A sample of seed flax which is made up of large plump viable seeds when used upon good even quality of ground and given other conditions of an equal nature will tend to ripen evenly. If, however, there are a lot of part immature, part injured seeds in the sample the plant will come up at different dates, grow at varying rates and produce a crop which will ripen unevenly.

2. Irregular Depths of Planting: Even if the sample of flax seed is made up of good quality of grain, if these grains are put into the ground at different depths, they will tend to come up at different periods, grow at an irregular rate, and at harvest time it will be found that some plants are thoroughly mature and others just in the blossom.

3. Various types of injury to the plants after they come out of the ground tend to produce uneven ripening partly, perhaps, through abnormal branching. Those plants which have been much whipped and blown about or lodged by the wind branch profusely, so that the bolls are mature on some branches and other branches may bear green ones or even flowers. Young plants partly cut off by cut worms or other insects mature at a later period than those which are uninjured. Young plants which are frosted back after three or four inches high, if not too badly frozen may produce branches and reach maturity at a later date than those which escaped the frosts.

The experiment showed that it was possible to raise a crop which would mature equally, that is, all the plants at the same time, no matter at what date the sowing was done, provided the seeds were select as to quality, that is, very evenly alike, and were sown in a very equal manner as to depth and quality of the soil.

The obvious conclusion to be drawn is that farmers should grade their flax seed to as even quality as possible, prepare as even a seed bed as possible and try to seed it all at an even depth. It was found on comparison that all the different seedings for

the different dates, etc., that one inch and a half depth gave the best growth during the past season. Flax which was actually down four inches deep failed to reach the surface strong enough to grow.

The Effect of Frost Upon Young Flax: The question is often asked if, when young flax plants are killed back by the frost they will grow again. It depends upon whether the frost killed the young plant back below the two seed leaves. Numerous observations were made during the early part of this season and no plant grew again which had the top killed below the seed leaves. Also on the 7th of July a heavy dust storm prevailed in portions of the state. Much flax was cut off by shifting dust and injured so that it wilted down by the action of the hot dry winds. None of these young plants were found to grow again if the injury extended below the first seed leaves. A bed of young flax five inches high, which was in vigorous growing condition was selected for experiment. All of the young plants were cut off by a sharp knife just below the point of attachment of the first seed leaves. None of these plants so treated put out any new sprouts. Another bed was cut back, but the cutting was done so that the seed leaves were left on the stems. Such plants branch freely from the axils of the seed leaves. These results are to be expected, as buds are not normally formed below the first seed leaves in dicotyledonous plants.

The Effect of Frost Upon Immature Flax: Much flax was planted in this state later than the 4th of July. Such plantings seldom produced mature flax before frost. Very many half mature bolls were thus frozen in varying degrees. Those frozen before maturity together with the wet damp weather immediately following seems to have been the chief cause of the presence of so much so-called scaly flax seed. The scaly character is due principally to the adherence of the immature portions of the bolls to the flax seeds. Numerous questions have been asked concerning the value of such flax seed. The chemist of the station has determined that this immature flax seed has fully as large a percentage, by weight, of oil as mature flax. Numerous germination testing made within the last few weeks, tend, however, to show that the germinating quality of such seeds is very low. It will take the work of another season to demonstrate the comparative value of such immature seeds when used for crop production.

Flax Wilt: During the present summer flax throughout this region has been subject to an infectious disease which has done an enormous amount of damage. For want of a better name and because of the peculiar action of the disease upon the plants, I shall hereafter speak of this disease as Flax Wilt. It has not so far as I know been previously studied in this country unless

Professor Luger in his descriptions of the flax sickness described in Bulletin No. 13, pages 20 to 25, of the Minnesota Experiment Station was considering this type of diseases. I think from his descriptions that this is true. The disease has, however, been quite accurately described so far as its general features are concerned, by Mr. Paul Nypels* as occurring in Belgium. The article in which the description is given does not assign any definite cause, other than that it is possible that it might be due to bacterial infection.

The general features of the disease are as follows: It has been found that after flax has grown for a number of years upon the same land that the crop becomes very much lessened in yield. This may not properly be ascribed to impoverishment of the land, because the chemical analysis shows that such is evidently not a fact, and because other crops which take essentially the same food elements from the soil grow luxuriantly. Professor Luger has affirmed as his conclusion in the matter that flax is "unkind to flax", indicating that in some manner it leaves the ground in a condition unsuitable for the growth of flax plants. In a field of sick flax there will be found large areas in which the plants are first rather quickly wilted and later die to the ground giving the whole field a spotted appearance.

On the college rotation plots it was found that in the first year's crop there were an even scattering of a very few sick plants throughout the plots. On the second year plots a few more. On plots on which there had been three crops there were quite large areas of dead plants. On the plots upon which flax had grown for seven years the entire crop was killed and no matter how many times it was reseeded the young plants very soon died to the ground. In a field that is not too heavily diseased one is able to find sick plants at all ages. Some die as soon as they get out of the ground. Others become yellow and finally wilt as late as blossoming time, perhaps even mature a few pods before dying.

The department has carried out numerous observations and experiments upon this disease during the past season, which when some further work has been done, I desire to publish in bulletin form. It is sufficient to state here the following essential points.

1. The disease has been found to be due to a parasitic fungus.
2. This parasite produces an abundance of spores, and lives both in the soil and in the old decaying flax stubble.
3. The disease may be started in a new field by the transfer of dirt from an infected field.

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* Compte-rendu de la séance du 5 décembre, 1897, de la Société Royale de Botanique de Belgique.

4. The disease may be transmitted to young healthy plants by infusions made from diseased plants.

5. Young healthy plants are uninjured by similar infusions made from healthy flax plants. This is contrary to the results obtained by Professor Luger. (See same citation.)

6. Observations upon a great number of fields in different parts of the state teach that the disease may be started in new or virgin soil by way of the seed flax. This is of much importance to farmers. It is not known how long this disease will remain in the soil when it once gets possession. Perhaps it may be found impossible to ever raise a good normal crop of flax upon the same soil again, thus great care should be taken in the procuring of flax seed to know that it has grown upon land which has not borne diseased flax plants. The action of the disease is peculiarly fitted to be effective in droughty conditions of the soil.

The fungus attacks the roots of the flax plants strongest in the neighborhood of the bottom of the furrow slice. The smaller roots quickly assume a pale darkish gray color, and finally the large root portions assume the same dead appearance and the plant rapidly wilts. Upon examination it is found that the parasite has filled vessels and tissues of the roots very thoroughly with its filaments. This is probably the explanation of why it did so much destruction during the past dry season, as there was very little moisture in the soil the plants were unable to make a rapid and vigorous growth and the fungus attacking the roots readily cut off the water supply from the leaves above, bringing about the typical wilting effect.

The study of the soil conditions in connection with the disease would seem to indicate that that preparation of the soil which would leave it in condition to best withstand drouth would be favorable to the flax plant and tend to produce a crop, when in a loose friable soil the disease would otherwise do great damage.

A large number of tests were made with the different fungicides and chemical substances, fertilizers, manures, etc., drilled into the soil with the seed in order to determine whether anything could be sowed with the seed which would prevent an attack upon the young plants when the ground was thoroughly diseased. These plantings were made upon the ground upon which a flax crop had completely died out on date of July 4th. Substances were placed in the drill in such quantities that it was feared that many of the young flax plants would be killed by the chemical nature of the treatment alone. A heavy shower on the day following the planting caused all of the plants to come up nicely. In nine days all of them had died to the ground thoroughly infected with the disease.

This set of experiments was radical enough in its nature to

teach that when the fungus has once infested the soil, it will be very difficult, if not impossible, to get any substance which will be effective against it and not injurious to the growing flax plants. The importance of procuring healthy seed is thus very much emphasized. There is much land in this state upon which flax has never been raised, and if possible to avoid it, the fungus should not be implanted in the land.

STUDIES UPON WEEDS IN 1900.

The Destruction of Weeds in Cereal Grains by Means of Chemicals Sprayed Upon the Foliage: In the tenth annual report I made a preliminary statement of the work which had been done in the line of the destruction of weeds in cereal grains by means of chemical sprays. Much interest has been taken in this subject by farmers and it was continued on as extensive a plan last season as time permitted. As stated in that report the work in the spring of 1899 gave much promises of success; so that we hope to be able to recommend that farmers use the method upon an extended scale. Later work, during 1899 and during the past season, teaches that in order to succeed each farmer will have to have much better judgment as to the time to spray than we had at first supposed.

It has been found that many conditions enter into the success of the work.

During the spring of 1899 very fine results were obtained by the use of commercial copper sulphate at the rate of one pound to four gallons of water, using at the rate of from ten to sixty gallons of solution per acre, according to the abundance of weeds.

The season was a rapid growing one, and young plants of king head, mustard, etc., died to the ground within a few hours after the application while the grain remain practically uninjured by the process. The work done during the summer of '99 and during the draughty conditions of 1900 demonstrated that these weeds do not always die down by the treatment so easily, indeed that in dry slow growing periods spraying should not be attempted.

Following the work in the spring of 1899, the following spraying tests were made:

1. Sodium arsenite in the following strengths and upon the dates listed. Applied to roadside weeds:

1. One ounce to four gallons August 1st, effective in two days. Too strong.

2. One ounce to three gallons, September 4th, effective in five days. Oldest not killed.

3. One ounce to three gallons, September 5th, effective in four days. All dead.

4. One ounce to two gallons, September 6th, effective in five days. All dead. (Too strong for timothy grass.)

5. Three ounces to four gallons, September 7th, effective in two days. Too strong.

6. One pound to 32 gallons, September 8th, effective on one-fifth acre Purslane.

7. One ounce to three gallons, September 11th, partly effective in five days.

8. One ounce to three gallons, September 13th, not effective.

Applied upon young weeds on summer fallow:

9. One ounce to three gallons, September 14th, not effective.

10. One ounce to two gallons, September 15th, effective.

11. One ounce to two gallons, September 18th, effective.

12. One ounce to three gallons, September 20th, not effective.

2. Sodium arsenate—applied to roadside weeds.

1. One ounce to four gallons, September 1st, not effective.

2. One ounce to three gallons, September 2nd. Plants recovered.

3. One ounce to two gallons, September 4th. Nearly effective.

4. One ounce to two gallons, September 5th. Not a success.

5. Three ounces to four gallons, September 6th. Not effective.

3. Copper sulphate applied to young weeds and wheat:

1. One ounce, chemically pure, to three gallons, September 13th. No effect.

2. One ounce, chemically pure, to three gallons, September 14th. Only slight effect.

3. One ounce, chemically pure, to four gallons, September 15th. No effect.

4. One ounce, chemically pure, two gallons, September 15th. Slight effect.

5. One ounce, commercial, to two gallons, September 18th. Slight effect.

6. One ounce, commercial, to three gallons, September 18th. No effect.

Salt applied to roadside weeds:

1. One pound to two gallons, September 4th. Effective.

2. Two pounds to one gallon, September 5th, effective. Too strong for wheat.

3. Three pounds to two gallons, September 6th. Effective in most cases.

4. Three pounds to four gallons, September 7th. Not effective.

5. One pound to one gallon, September 8th, effective. Too strong for wheat.

Salt applied to young weeds and cereals:

6. One pound to one gallon, September 14th. Not satisfactory. Injured grain plants. Did not kill weeds.

7. Three pounds to two gallons, September 15th. Not satisfactory as above.

8. One-half pound to one gallon. Not effective.

A number of other substances were tested without promise of particular value. The results of the work at this time of the year was unsatisfactory. No success may be hoped for in killing old weeds by means of chemicals. They withstand approximately as much injury as the cereals.

Destruction of Weeds by Spraying in 1900: The past spring, effort was made to work upon a scale extensive enough to afford a basis upon which recommendations could be made. The results have been discouraging to our hopes that an easy road to weed extermination had been reached, but very instructive and warrant further work, when taken in relation to the fine results accomplished in the spring of 1899, when it was shown that treatment easily doubled the yield of oats upon weedy ground.

No. of test	Date of test	Chemical used	Strength of solution	Area treated	General result of the treatment
1	May 22	Sodium arsenite	1 oz. to 3 gallons	4 sq. rods	No satisfactory results, mustard matured. Hot, dry and windy. Dried off too quickly.
2	May 22	Copper sulphate (commercial)	½ lb. to 3 gallons	4 sq. rods	Oats not permanently injured, mustard killed or stunted, effect quite good.
3	May 24	Copper sulphate	1 lb. to 4 gallons	4 sq. rods	Nearly a success. Oats injured a little, as not enough rain fell to free the leaves of this chemical. For same reason the effect was spotted upon the mustard—as rain failed to spread the solution on the leaves.
4	May 24	Copper sulphate (commercial)	1 oz. to 3 gallons	4 sq. rods	Effective when upon thoroughly sprayed weeds, except Thlaspi. Some injury to oats. Too dry, hot and windy.
5	May 25	Copper sulphate (commercial)	1 lb. to 3 gallons	4 sq. rods	Success upon all young weeds. Too strong upon oats, if thoroughly wet with fine spray. Weather too hot, dry and windy. No growth, so oats could not recover as usual.
6	May 25	Sodium arsenite	2 ozs. to 3 gallons	4 sq. rods	Hurt oats more than last. Effect on weeds more irregular. Too strong for thorough application in this weather.
7	May 31	Copper sulphate (commercial)	1 lb. to 4 gallons	6 sq. rods	Slight rain June 1st. Wet weather success. Killed mustard, buckwheat, kinghead, young French weed, hurt the oats because of the dry time following, where too thoroughly sprayed.
No. 8	June 1, a. m.	Sodium arsenite................	1 oz. to 2 gals. water............	6 sq. rods	No result. Slight rain after application seems to have prevented all action of the arsenite.

No. of test	Date of test	Chemical used	Strength of Solution	Area treated	General result of the treatment
9	June 1.........	Copper sulphate (Com.)....	1 lb. to 4 gallons..............	8 sq. rods	Could not wet Hare's ear mustard. Effective on mustard and buckwheat. Success due to small shower during morning just previous to application, and one on June 3rd. Oats hurt, but recovered after 3rd. Dandelions killed to ground recover.
11	June 1, 4 P. M.	Sodium arsenite.............	1 oz. to 2 gallons..............	....	Applied after rain. Killed all weeds. Too hard on oats when it was thoroughly applied.
12	June 1, 12 M...	Copper sulphate............	1 lb. to 4 gals., 12 gallons.....	¼ Acre...	Hot, dry wind blowing—dried too quickly. Most mustard plants stunted some, but able to recover. The plants on this plot old and tough due to drouth.
13	June 2.........	Sodium arsenite............	½ lb. to 12 gallons............	¼ Acre...	Weeds too old and tough due to the dry weather and slow growth. Mustard plants grown in this dry windy weather will not wet with the solution as they do if quickly grown. No success.
14	June 12, after shower......	Copper sulphate, (Com.)...	1 lb. to 4 gallons, 12 gals......	¼ Acre...	Shower 9 A M. to 11 A. M., June 13, youngest weeds effectively killed, old ones wilting. June 21st, grain hurt some, oldest weeds recovering.
15	June 2, after shower......	Sodium arsenite............	1 lb. to 32 gals., 12 gals used..	¼ Acre...	Result about as in last, more irregular. Grain hurt more than in last, and more weeds recovered although many were killed.

A study of these results and the observations made on the field teach that both these chemicals may be effectively used against all weeds which have a surface upon which the solution will spread.

Hare's ear mustard (Conringia Orientole) and French weed (Thlaspi arvense) are hard to wet except when very young. Spraying will not be effective upon these unless quite young. Common mustard and kinghead are easily wet and readily die in a few hours when in rapid growth conditions.

It is useless to expect desirable results by spraying in drouthy windy weather. Even mustard quickly becomes too hardy and can resist, while the central growth from the cereals not being rapid at such times, these plants also become injured by the cumulative effect of the poisons.

Recommendations: If both grain plants and weeds are rapidly growing success can be scored with either sodium arsenite or copper sulphate. The latter is the most reliable.

1. Use copper sulphate at rate of one pound to four gallons of water or,
2. Use sodium arsenite at the rate of one pound to thirty gallons of water.
3. Unless the weeds are evenly distributed spray only the weed areas.
4. Carry the solution in a hand spray cart or in barrel or tank spray upon wagon, according to work to be done.
5. One man to work the force pump and one or more to walk about the wagon with spray hose and nozzle can rapidly and effectively cover the ground.
6. The nozzles should be carried upon poles at least ten feet long so as to allow rapid movement to avoid waste of solution when weeds are scattering.
7. Select nozzles which throw fine drops rather than misty sprays.
8. Spray just after a rain rather than just before.
9. Do not spray unless both grain plants and weeds are succulent, rapidly growing.
10. Spray just after most of the young weeds are out of the ground at least before any mustard is in blossom. Preferably before the cereal has reached a height sufficient to form stems say not to exceed 5 to 10 inches high.
11. Success is not sure to follow; for weather conditions have such invariable influence on this work, but to combat mustard where too thick to pull I believe nothing can be lost in the process in an ordinary growing season, and there is much to gain.

The Life of Weed Seeds in the Red River Valley Soil: Record was made in the tenth annual report of this station, page 26, of the outline of an experiment to test the growth of weed seeds

planted at different depths in the heavy soil of the college farm. The place selected for the experiment was somewhat lower and less well drained than the average soil of the valley, the water table often reaching to within a few inches of the surface for short periods of time during the wet season. No seeds have been taken up yet for tests, records only being made of those which grew during the fall of 1899 and during the summer of 1900. The former records are to be had from the tenth annual report, pages 26 and 27. The growths for this year are given below.

April 7th. Seeds of Shepperd's Purse (Capsella). French weed (Thlaspi), mustard (Brassica), which were one inch deep were coming up in large numbers.

April 21st. Greater Ragweed, Kinghead (Ambrosia) was up from one to two inch plantings.

Mustard and French weed a few from 2 inches depth.

Wild Buckwheat (Polygonum) was putting up plants from one and two inch plantings.

April 28th. Wild oat (Avena), showed a few plants from one inch, two inch and three inch plantings.

August 5th. Pigeon grass (Setaria) showed a few plants from one inch plantings. Mustard also showed a few plants at this date from three inches deep.

The following summaries of growths from the different buds represent the different growths made. All plants were pulled upon the date of the count.

Bed No. 1. Shepperd's Purse (Capsella bursa pastoris.)

May 12th. From one inch plantings, pulled 230 plants from three inches of row. The others pulled but not counted.

June 5th. From one inch plantings, pulled 70 plants from the row.

Bed No. 2. French Weed (Thlaspi arvense).

May 12th. From one inch plantings, pulled 783 seedlings.
May 12th. From two inch plantings, pulled 16 seedlings.
June 5th. From one inch plantings, pulled 2 seedlings.
August 28th. From one inch plantings, pulled 160 seedlings.

Bed No. 3. Pigeon Grass (Setaria vividis).

May 18th. From one inch plantings, pulled 1104 seedlings.
May 18th. From two inch plantings, pulled 366 seedlings.
June 5th. From one inch plantings, pulled 190 seedlings.
June 5th. From two inch plantings, pulled 140 seedlings.
June 5th. From three inch plantings, pulled 169 seedlings.

Bed No. 4. Kinghead (Ambrosia trifida).

May 12th. From one inch plantings, pulled 100 seedlings.

May 12th. From one inch plantings, pulled 217 seedlings.
May 12th. From three inch plantings, pulled 91 seedlings.
June 5th. From one inch plantings, pulled 2 seedlings.
June 5th. From two inch plantings, pulled 1 seedling.
June 5th. From three inch plantings, pulled 12 seedlings.
June 5th. From four inch plantings, pulled 9 seedlings.

Bed No. 5. Common Mustard (Brassica sinapistrum).

May 18th. From one inch plantings, pulled 730 seedlings.
May 18th. From two inch plantings, pulled 635 seedlings.
May 18th. From three inch plantings, pulled 290 seedlings.
June 5th. From one inch plantings, pulled 20 seedlings.
June 5th. From two inch plantings, pulled 19 seedlings.

Bed No. 6. Wild Buckwheat (Polygonum Convolvulus).

May 12th. From one inch plantings, pulled 137 seedlings.
May 12th. From two inch plantings, pulled 64 seedlings.
May 12th. From three inch plantings, pulled 80 seedlings.

Bed No. 7. Wild Oat (Avena fatua).

May 12th. From one inch plantings, pulled 43 seedlings.
May 12th. From two inch plantings, pulled 31 seedlings.
May 12th. From three inch plantings, pulled 40 seedlings.
June 5th. From one inch plantings, pulled 23 seedlings.
June 5th. From two inch plantings, pulled no seedlings.
June 5th. From three inch plantings, pulled 13 seedlings.

It is interesting to notice the effect of depth of planting. No seedling has reached the surface from a greater depth than four inches.

Shepperd's Purse has not sent up plants from a depth of over one inch.

French weed has no record below two inches.

Mustard and pigeon grass sent up the most plants from one inch depth.

Kinghead did best from two inches, did well from three inches, and sent up some late plants from a depth of four inches. Wild oats did equally well from one inch to three inches and sent up some plants from four inches deep.

These members of the mustard family were the earliest to start, closely followed by the Kinghead.

These figures as to depth are instruction as to how deep to cultivate a summer fallow. Four inches seems to be almost the exact depth if wild oats and kinghead are to be killed, and at least three inches for mustard, but not deeper.

Records will be taken upon these beds during 1901.

The Seed Bearing Plants of the State: The work of systematizing the collection of seed bearing plants of the state now in

the Herbarium and of constructing a preliminary list has been continued. The list has been published as Experiment Station Bulletin No. 46 under the title "Preliminary List of the Seed Bearing Plants of North Dakota." With the possible exception of the grasses and a few of the smaller orders of plants, the list is in no manner to be considered a complete one. As a beginning and aid it is hoped that it may prove of benefit to many.

Correspondence: One of the ways in which this department of the station finds that it can be of much service to the residents of the state is along the line of question answering by mail. Since the last report there have been answered 417 letters upon botanical or biological subjects as applied to farm matters or practice. These chiefly relate to the subjects of disease, weeds, seed examination or to general questions upon which the department has or is experimenting.

Judging from the tendency of many farmers to make use of inferior grain for seed, and the desire manifested to learn along the lines of seed studies, a department devoted entirely to seed examination testing and investigation would be of great economic value to the state.

An Observation Upon the Growth of Red Clover Seed: The common belief that Red clover (Trifolium pratense) needs the presence of bumble bees or other large insects to carry pollen, in order that the ovules may be fertilized, I think must be discarded. This plant is very prolific in the production of mature seeds in all parts of this state, practically every flower of a head being fertile. The bumble bee is a very scarce insect in North Dakota, seldom being seen. I do not know of any other insects sufficiently numerous to visit all the flowers in all of the heads of all the fields of North Dakota or indeed for any state. The plant, it seems, must be fertilized chiefly by wind carried pollen.

Assistance: As general assistant in the department of biology of the college and station, Mr. Lawrence R. Waldron has rendered efficient service in all of the different lines of station work.

Respectfuly submitted,

HENRY L. BOLLEY, Botanist.

AGRICULTURAL DEPARTMENT.

To Director J. H. Worst:

During the past year this department has devoted a large amount of time to farmers' institute work.

Personally I have taken part in twelve or fifteen such meetings, including the grain growers convention and the state Chautauqua assembly, while the assistant agriculturist has been called upon for a similar amount of time.

The number of special letters in reply to specific questions has also greatly increased and requires a large amount of time and energy. The number of such letters answered during the past season was 239 and during some months numbered three to five a day.

Wheat experiments have received much work during the past season. Selection and breeding with wheat has been carried forward in an extended way and with good success.

The awarding of a gold medal by the Paris exposition authorities to this station upon a display of the results of breeding and selecting wheat as shown by this department indicates the degree of success which that work is meeting.

The results from the other work done with wheat, oats, barley, spelt, flax, flax and wheat mixed, buckwheat, beans and from trials of the value of old and sprouted seeds for planting are published in detail in this report.

An extended study of Indian corn has been made, the results for which I hope to submit to you in bulletin form, at an early date. The loss of a large quantity of our pedigreed varieties of corn by fire January 4th will cause the time of our being able to distribute them by sale to be delayed two years or more.

I desire to report that small quantities of seed of each distinct variety of corn and of all cereals and other plants of any particular importance had been placed in other buildings as a matter of precaution, and by reason of that fact have been saved from extinction. The quality of seed wheat for distribution by sale and also the seed corn which was ready to be put out in the same way were in other buildings and consequently are preserved and being sent out.

The rotation trial was continued during the past year and added more information than it has during any single season it

was instituted. The limited space available in this report makes it necessary to hold that data for publication in bulletin form at a later date.

The study in methods of cultivation and the preservation of soil moisture were given extended study during the past year and yielded some valuable information both as to the actual holding of moisture by tillage methods and in the yields of various crops produced.

A study of the effect of different methods of cultivation upon the blowing or drifting of soil has been carried on but while some progress has been made it is proving a difficult line of experimentation.

The study of the root systems of plants was given a limited amount of study and makes an interesting record of their behavior during an extraordinary dry season.

Pasturing trials with sheep and hogs upon cereals and rape were begun during the past season and a limited amount of good data was secured.

Feeding trials with horses and mules have been continued, a limited way and will form a good basis for future work of a similar character.

Feeding trials with horses and mules have been continued. a report upon which I made you in bulletin No. 45 last September.

The distribution of wheat by sale is coming fully up to my expectation. I have reports of 13,050 bushels of it in pure condition now in the hands of farmers in eleven counties in this state. This has all sprung from the distribution by sale of small samples by this station, the amount ranging from thirty pounds to five bushels in quantity.

These growers are acting as farm seedmen by selling this wheat to their neighbors.

J. H. SHEPPERD.

GRAIN AND FORAGE CROPS.

This report gives the result of trials carried on in 1899 and 1900 in rather extended detail. In cases where the results for the past two years are but a continuation of work which has been in progress for several seasons the average results for the entire time have been given and conclusions drawn from the entire list of results.

The crop work of this department for the past two years has been chiefly a continuation of the experiments reported and discussed in Bulletin No. 39. The study of flax has been extended and will be carried forward in considerable detail during the coming season.

The soil methods of handling and general conditions described in Bulletin No. 39 hold for the work of the past two seasons. Wheat was attacked by rust early in the season of 1899, which has probably reduced both the yield and grade, while in 1900 the extreme drouth which prevailed caused a light yield of grain.

As each sample of seed of the various grains, etc., is received by this department it is given a number in our record book, under which is noted the character of the seed, from whom received, date of receipt, etc. This number is called a "Record Number" and goes with each variety of seed as a part of its name, on our records. In publishing the results of our experiments it has been found convenient and advisable to number each variety in the several classes of grains, etc., in the order in which they are published. This number is called a "Bulletin Number." This system has been carried out with wheat, oats and barley from the start, but some of the products reported upon in Bulletin No. 39, were designated by their "Record Number." In this publication wherever the variety number has been changed, attention has been called to the fact by foot notes.

VARIETIES OF WHEAT.

Sixty-three varieties of wheat were grown in this trial in 1899. The land used for the trial grew a crop of corn in 1898 and was fall plowed late. The grain was sown from May 5th to 8th and harvest was completed August 12th.

Table 1 gives a description and record of the varieties grown in 1899.

TABLE I.—VARIETIES OF WHEAT.

Bulletin Number	Variety	Where from Originally	First crop grown at this station	Days maturing	Length of stem	Bearded, smooth or velvety chaff	Length of heads	Grain				Average yield per acre—1898 and 1899 crops
								Grade	Hard wheat	Weight per bushel	Yield per acre	
			Yr		In		In		P C	Lb	Bu	Bu
23	Red Fife	Agricultural College, Guelph, Ont., Can.	1892	98	41	Sm'h	3	3 N	90	58½	25	28.5
50	Wellman's Fife	Experiment Farm, Brandon, Manitoba	1892	99	40	"	3	2 N	95	59	24.3	29.3
66	Exp. Station Fife	J. B Power, Power, N. D.	1892	98	39	"	2¾	2 N	95	59½	24.7	29.7
120	Glyndon (774)	Russia, by Minn. Exp. Station	1892	98	40	"	2⅞	2 N	95	59	23.2	28.1
146	Bolton's Blue Stem	Thos. Bolton, Park River, N. D	1893	98	43	Velv.	3¼	3 N	90	57¾	26.6	31.5
148	C. & C. Land Co.'s Fife	C. & C. Land Co., Jamestown, N. D	1894	98	42	Sm'h	3	3 N	95	58	23.6	29.9
149	Minn. No. 19, White Russian	Minn. Exp. Station	1896	98	44	"	3½	3 N	90	58½	23.8	31
151	Minn. No. 105, Glyndon (711)	Minn. Exp. Station, same as N. D. No. 105*	1896	98	40	"	3	2 N	90	59	24.8	29.9
155	Minn. No. 146, Bolton's Blue Stem	Minn. Exp. Station, same as Bolton's B. S. No. 146*	1896	98	43	Velv.	3¼	2 N	95	58½	26.5	31.
176	Glyndon (811) Fife	Minn. Exp. Station, same as N. D. No. 123*	1986	98	42	Sm'h	3	2 N	95	58½	25.8	31.9
178	†Selected Power's Fife	" " " original seed, same as N. D. No. 66	1896	97	39	"	2⅞	3 N	90	58½	24.2	30.2
194	Advance	Prof. Wm. Saunders, Ottawa, Can., in 1894, by Minn. Exp. Station	1896	96	41	Ber'd	2⅞	3 N	90	58¼	22.7	27.8
195	Crown	Prof, Wm. Saunders, Ottawa, Can., in 1894, by Minn. Exp. Station	1896	94	39	"	2⅞	2 N	95	58½	22.3	27.9
196	Stanely	Prof. Wm. Saunders, Ottawa, Can., in 1894, by Minn. Exp. Station	1896	94	39	Sm'h	2⅞	3 N	90	58¼	21.2	26.6
197	Preston	Prof. Wm. Saunders, Ottawa, Can., in 1894, by Minn. Exp. Station	1896	93	43	Ber'd	3	3 N	50	58¾	27.6	32.8
198	Percy	Prof. Wm. Saunders, Ottawa, Can., in 1894, by Minn. Exp. Station	1896	92	42	Sm'h	2⅞	Rej.	50	57½	22.8	27.1
202	Minn. No. 19, White Russian	Minn. Exp. Station, same as N. D. No. 149.	1897	98	44	"	3½	2 N	95	59¼	25.3	27.7
203	Minn. No. 51, Haynes' Blue Stem	Minn. Exp. Station, same as N. D. No. 51,* originated by L. H. Haynes, Fargo, N.D.	1897	98	45	Velv.	3½	2 N	90	58	26.4	29.9
204	Minn. No. 66 Power's Fife	Minn. Exp. Station, same as N. D. No. 66*.	1897	98	41	Sm'h	3	2 N	95	59¾	24.5	28.2
207	Minn. No. 116, Glyndon (753)	" " " " " " " 116*.	1897	98	40	"	3	2 N	95	58½	23.2	28.2

208	Minn. No. 146, Bolton's Blue Stem	Minn. Exp. Station, same as N. D. No. 146*	1897	98	45	Velv.	3½	2 N	90	58	26.4	30.9
209	Minn. No. 149, †Selected Power's Fife	" " " original seed was Powers' Fife No. 66	1898	99	40	Sm'h	3	2 N	95	59½	24.	28.9
210	Minn No. 155, †Selected Glyndon (818) Fife	Minn. Exp. Station, original seed was N. D. No. 129	1898	99	40	"	3	2 N	95	59½	23.6	29.4
211	Minn. No. 157, †Selected Glyndon (753) Fife	Minn. Exp. Station, original seed was N. D, No. 116	1898	98	41	"	3	2 N	95	58.	24.5	30.5
212	Minn. No. 163, †Selected Glyndon (811) Fife	Minn. Exp. Station, original seed was N. D. No. 123	1898	97	42	"	3	2 N	95	58½	25.9	31.6
213	Minn. No. 167, † Selected Glyndon (761) Fife	Minn. Exp. Station, original seed was N. D. No. 117	1898	98	43	"	2⅞	2 N	75	59.	24.8	29.8
214	Minn. No. 169, †Selected Haynes' Blue Stem	Minn Exp. Station, original seed was N. D. No. 51	1898	99	45	Velv.	3½	2 N	95	57¾	25.7	32.1
215	Minn. No. 171, †Selected Rysting's Fife	Minn. Exp. Station, original seed was received from Jens Rysting, Buxton, N. D.	1898	99	42	Sm'h	3½	2 N	98	58½	26.6	32.4
216	Minn. No. 181, †Selected McKendry's Fife	Minn. Exp. Station, original seed from Assiniboine Valley	1898	99	40	"	3⅛	2 N	95	59½	24.6	30.1
217	Minn. No. 185, Advance	Minn. Exp Station, same as N. D. No 194.	1898	95	40	Ber'd	3	2 N	90	59	21.9	27.5
218	Minn. No. 188, Preston	" " " " " " " 197	1898	94	39	"	2¾	3 N	90	59	26.2	31.3
219	Russian	Russia, by U. S. Dept. of Agr	1898	90	39	"	2¾	Rej.	50	55¾	17.1	17.4
220	Haynes' Pedigree Blue Stem	L. H. Haynes, Fargo, N. D	1899	99	44	Velv.	3½	3 N	95	57	23.5	
221	Defiance	Colorado Exp. Station	1899	97	38	Sm'h	2¾	Rej.	Soft	56	17.1	
222	Pererodka, U. S. No. 2,954	Russia, by U. S Dept. of Agr	1899	97	47	Ber'd	2⅜	2 N	Soft	60	34.9	
223	Kubanka, U. S. No. 2,953	" " " " " "	1899	97	47	"	2½	3 N	Soft	60½	30.1	
224	Russian, U. S. No. 2,955	" " " " " "	1899	97	40	"	2¾	3 N	80	59	14.5	
225	Marvel	Salzer Seed Co	1899	98	42	Velv.	3¼	2 N	95	57¾	23.2	
226	Selected Rysting's Fife	N. D. No. 215, selected for hard wheat	1899	99	41	Sm'h	3¼	2 N	98	58½	26.	
227	" " "	" " " " " soft "	1899	99	43	"	3¼	2 N	95	58½	26.4	
228	*Minn. No. 51, Haynes' Blue Stem	Minn. Exp. Station	1899	99	42	Velv.	3⅜	2 N	90	57	24.7	
229	*Minn. No. 66, Power's Fife	" " "	1899	97	41	Sm'h	2¾	2 N	95	59	23.5	
230	*Minn. No. 105, Glyndon (711)	" " "	1899	97	41	"	2¾	2 N	95	58½	22.3	
231	*Minn. No. 146, Bolton's Blue Stem	" " "	1899	96	44	Velv.	3¼	3 N	90	57	23.2	
232	†Minn. No, 163, Glyndon (711)	" " "	1899	96	41	Sm'h	2¾	2 N	90	57¼	22.4	
233	Minn. No. 185, Advance	" " "	1899	92	39	Ber'd	3	3 N	90	58½	19.5	
234	Minn. No. 188, Preston	" " "	1899	92	40	"	2¾	3 N	50	59¼	23.9	
235	Red Fife	Exp. Farm, Brandon, Man	1899	96	42	Sm'h	2¾	2 N	90	59	23.2	
236	Wellman's Fife	" " " "	1899	95	45	"	3½	2 N	90	58¾	26.9	
237	Early Wonder	L. L. May & Co	1899	95	41	"	3	2 N	95	59	24.	
238	Advance	Central Exp. Farm, Ottawa, Ont	1899	92	40	Ber'd	3	2 N	50	59	24.4	
239	Preston	" " " " "	1899	92	41	"	3¼	3 N	25	59½	24.2	
240	Stanley	" " " " "	1899	91	38	Sm'h	2¾	2 N	90	59	22.1	
241	Crown	" " " " "	1899	91	39	Ber'd	2⅞	Rej.	Soft	59¾	24.6	
242	Percy	" " " " "	1899	92	37	Sm'h	2⅝	2 N	50	58½	18.9	
243	Improved Saskatchewan Fife		1899	96	38	"	2¾	2 N	90	59	21.4	
244	Selected Blue Stem		1899	99	40	Velv.	3½	3 N	90	56¼	19.7	
245	Montana Spring Fife	Montana Exp. Station	1899	98	41	Sm'h	3½	3 N	95	58	21.2	
246	Spring Club	" " "	1899	93	37	"	2½	Rej.	....	47	8.2	

*Varieties were all originally grown at this sta., (see bulletins 10, 11, 23 and 39.) The Minn. Exp. Sta. secured seed from this sta. in 1893. †Selections made from single plants grown at Power, N. D. in 1892, by Prof. W. M. Hays, now of the Minn. Exp. Station; seed taken by him to that station in 1893.

The varieties which are marked "selected" are new improved kinds originated by breeding and selection. This station has bred and selected wheat for nine years. In 1898 twelve of the best of the forty kinds grown the previous year were seeded in large quantity. The new kinds are very promising and represent the best of many thousand plants, grown from the best original kind found in extensive variety trials.

TABLE II. VARIETIES OF WHEAT GIVING LARGEST YIELD IN 1899.

Bulletin No.	Variety	Grade	Hard wheat	Weight per bu.	Yield per acre
			Per ct.	lb.	Bu.
222	Pererodka, U. S. No. 2954	2 N	soft	60	34.9
223	Kubanka, U. S. No. 2953...	3 N	"	60½	30.1
197	Preston....................	3 N	50	58¾	27.6
236	Wellman's Fife............	2 N	90	58¾	26.9
215	Selected Rysting's Fife....	2 N	98	58½	26.6
146	Bolton's Blue Stem.........	3 N	90	57¾	26.5
203	Haynes' Blue Stem.........	2 N	90	58	26.4
212	Selected Glyndon Fife (811)	2 N	95	58½	25.9
176	Glyndon Fife (811).........	2 N	95	58½	25.8
214	Selected Haynes' Blue Stem	2 N	95	57¾	25.7
202	White Russian.............	2 N	95	59¼	25.3
23	Red Fife...................	3 N	90	58½	25
151	Glyndon (711)..............	2 N	90	59	24.8
213	Selected Glyndon Fife (761)	2 N	75	59	24.8
66	Experiment Station Fife...	2 N	95	59½	24.7

TABLE III. VARIETIES WHEAT GIVING LARGEST AVERAGE YIELDS FOR TWO YEARS, 1898 and 1899.

Bulletin No.	Variety	Grade		Hard wheat avg.	Weight per bu.	Yield per acre
		1898	1899	Per ct	lb.	bu.
197	Preston....................	1 N	3 N	63	59¾	32.8
215	Selected Rysting's Fife....	1 N	2 N	90	59⅜	32.4
214	Selected Haynes' Blue Stem	1 N	2 N	90	59	32.1
212	Selected Glyndon Fife (811)	1 N	2 N	93	60	31.6
146	Bolton's Blue Stem	1 N	3 N	85	58⅜	31.5
176	Glyndon Fife (811).........	1 N	2 N	95	95¼	31.4
149	White Russian.............	2 N	3 N	58	58⅝	31.0
211	Selected Glyndon Fife (753)	1 N	2 N	95	59½	30.5
178	Selected Power's Fife......	1 N	2 N	96	59¼	30.2
216	Selected McKendry's Fife..	1 N	2 N	88	59⅞	30.1
151	Glyndon (711)..............	1 N	2 N	88	59¾	29.9
203	Haynes' Blue Stem.........	1 N	2 N	90	59¼	29.9
148	C. & C. Land Co's Fife.....	1 N	3 N	93	59⅛	29.9
213	Selected Glyndon Fife (761)	2 N	2 N	63	60	29.8
66	Experiment Station Fife...	1 N	2 N	90	60⅛	29.7

TABLE IV. VARIETIES OF WHEAT TESTED FOR SIX YEARS, 1893, '94, '95, '97, '98 and '99.

Bulletin No.	Variety	Grade					Hard Wheat avg.	Yield per acre avg.
		1893	1894	1895	1898	1899	Per ct.	Bu.
146	Bolton's B. S........	1 N	1 N	1 N	1 N	3 N	82	24.2
66	Experiment station Fife.......... ..	1 H	1 H	1 H	1 N	2 N	89	23.5
23	Red Fife............	1 H	1 H	1 H	1 N	3 N	86	22.8
120	Glyndon (774).......	1 H	1 H	1 H	1 N	2 N	90	22.8

Numbers 222 and 223 Russian varieties imported by the U. S. department of agriculture, from the Russian crop of 1898, outyielded our best standard fife and blue stem varieties four and eight-tenths and eight bushels per acre, respectively. Unfortunately they belong to a class known as flint wheat, and botanically as Triticum durum, instead of Triticum vulgare or common wheat. This thrifty heavy yielding wheat does not mill well and while it is good for making maccaroni and can be used in preparing breakfast foods, there is little demand for it and consequently nothing to be made by growing it in its present form in a hard wheat district.

It is a better grade of wheat than the wild goose wheat variety, but is like it in being a flint wheat. These new Russian wheats will be placed in the breeding trials where they may infuse their blood with good effect into some of the standard strains of the fife and blue stem sorts.

Preston No. 197, the wheat which ranked third in yield in 1899 and first in the average for 1898 and 1899 is a bearded wheat, rather soft in quality and low in grade. It was originated by Dr. William Saunders at the Dominion Experiment station, Ottawa, Canada, by cross-breeding and selection. It is an early wheat and hardy, in addition to being a large yielder.

Minnesota No. 171, a new fife variety originated by the Minnesota station has ranked highest in our trials—all points considered—during the past two years and has been increased in quantity until we expect to be able to distribute it by sale, in 1902. Minnesota No. 169, a blue stem variety descended from seed originally obtained from Thos. Bolton, Park River, N. D., ranked fifth in the two year trial, but yielded a fraction of a bushel less per acre than Minnesota No. 163, the fife variety which this station is now sending out. The station is now prepared to distribute a limited amount of seed wheat by sale, to citizens of this state.

There were fifty-one variety of wheat in the trial of 1900. The varieties were grown upon land which produced corn in 1899, but the corn crop consisted of several experiments with different varieties, different methods of cultivation, different thickness of planting, etc., and by reason of that fact the land was not subjected to exactly the same condition of cropping. It became evident before harvest time that there was a greater difference in the wheat growing upon the several plots, than could be reasonably attributed to the difference in varieties. Careful observation showed that the different methods of cropping with corn in 1899, had produced a strong influence on the wheat crop in the dry season of 1900.

When the grain was threshed and weighed it was found that the yields varied from ten to twenty-nine bushels per acre, too large a difference to be attributed to difference in variety alone. It was found, however, that the differences in yield could be accounted for in part by the early maturing of some varieties of wheat and the late maturing of others, the later maturing sorts having been unusually favored by the rains which fell during the latter part of the growing season.

As a trial of varieties the results were not considered fair and the yields have not been included in this report.

CHANGING SEED WHEAT.

In this trial of a change of seed wheat with the Minnesota station, the breed or variety effect has been carefully eliminated by using seed descended from grain which was originally grown at this station. In other words the grain compared in this trial came originally from the same bag of seed.

In the comparison of twenty-three samples of home grown seed, with that which had spent a vacation of from one to nine years at the Minnesota station, the home grown seed outyielded that which had been grown for a time in Minnesota except in a single case. The decrease is marked for the first and second years after it was returned, while the third crop showed the effect to only a slight degree. There was no marked difference in the grade and weight per bushel of the grain produced. The accompanying summarized table gives a more detailed statement of the yields secured.

TABLE V.—SUMMARIZED RESULTS OF EXPERIMENTS IN CHANGING SEED WHEAT.

No. of Trials	Kind of Seed	Average yield per acre	Difference in favor of older seed
		Bu.	Bu. per acre
	Home grown, 3 to 9 years	21.6	
8	New, direct from Minnesota	18.6	3.0
	Home grown, 2 years	29.0	
5	New, direct from Minnesota	27.7	1.3
	Home grown, 1 year	16.2	
4	New, direct from Minnesota	14.1	2.1
	Home grown, 2, 3 and 9 years	32.4	
6	Home grown, 1 year	29.5	2.9
	Home grown, 2, 3 and 9 years	25.1	
23	New seed or home grown, 1 year	22.66	2.44

The average results from twenty-three trials, with the wheat which had been grown by the Minnesota station in a manner similar to our own method of handling it, show a loss in yield of nearly two and a half bushels per acre with no practical difference in the grade.

In the spring of 1899 a change of seed of several varieties of wheat with the Dominion Experiment station at Ottawa, Canada, was secured. Our seed of the varieties tried had come originally from the Central station at Ottawa, and hence was of the same breeding. The results from this trial are not so uniform and regular as those from the Minnesota trial and can scarcely be taken as an indication of either inferior or superior yields. The tabulated statement submitted herewith gives the data recorded in 1899.

TABLE VI.—SHOWING RESULTS OF CHANGING SEED WHEAT WITH THE DOMINION EXPERIMENT STATION, OTTAWA, CANADA. CROP OF 1899.

	Seed grown at this station since 1896.			Seed received from Ottawa in 1899.			Difference of yield in favor of old wheat
Variety	Yield per acre	Grade	Hard wheat	Yield per acre	Grade	Hard wheat	Per acre
	Bu.		Per ct	Bu.		Per ct	Bushels
Advance........	22.7	3 N	90	24.4	2 N	50	-1.7
Crown..........	22.3	2 N	95	24.6	rej't	soft	-2.3
Percy...........	22.8	rej't	50	18.9	2 N	50	3.9
Preston.........	27.6	3 N	50	24.2	3 N	25	3.4
Stanley.........	21.2	3 N	90	22.1	2 N	90	0.9
Average......	23.3			22.8			0.5

QUANTITY OF SEED WHEAT PER ACRE.

Experiment station fife 66 was the seed used in this trial.

Observations made on the crop of 1899 show that the thick sown wheat ripened a day or two earlier than the thin sown grain. The straw was weaker and lodged more on the thick sown plots. Ten per cent of the grain seeded at the rate of eight pecks per acre was lodged while that sown at the rate of three pecks per acre did not lodge. The latter however, rusted worse than the thick sown wheat. The thick sown wheat did not grow so high and had shorter and smaller heads than the thin sown grain.

In 1900 the trial was made on ground which grew potatoes in 1899. The test was considered fair and the yields and weights per bushel of this crop have been included in Table VII. In this trial the wheat varied less than in 1899. The height of straw varied from twenty-eight inches for the thickest sown grain to thirty-one inches for that sown thinnest. The heads were of good length and quite uniform in size, and there was very little difference in the time of ripening, all plots being harvested on the same date, July 1st. Table VII gives some of the data collected on this subject:

TABLE VII.—AMOUNT OF SEED PER ACRE.

Plot Number	Seed sown per acre	Crop of 1899							Crop of 1900		Average for '98, '99, 1900	Average for seven trials
		Stand	Height	Length of Heads	Grade	Hard Wheat	Weight per bu.	Yield per acre	Weight per bu.	Yield per acre	Yield per acre	Yield per acre
	Pks.		In.	In.		Per cent	lb	bu.	lb	bu.	bu.	bu.
1	3	Good...........	42½	3¼	3 N	95	59	18.5				
2	4	Good...........	41	3¼	3 N	95	58½	17.8	60½	23.9	25.1	18.3
3	4½	Good...........	42	3¼	3 N	95	58½	18.0	60	23.9	24.9	19.3
4	5	Quite thick.....	41	3	3 N	95	58½	19.4	59¼	23.5	25.1	19.1
5	5½	Thick..........	41	3	3 N	95	58¾	18.1	59¾	23.6	25.9	20.1
6	6	Thick..........	41	2¾	3 N	95	58½	19.5	60	26.2	27.1	19.8
7	7	Very thick.....	40	2½	3 N	95	58¾	19.4	59¾	26.0	27.4	
8	8	Very thick.....	40	2¼	3 N	95	58¾	21.2				

Five and one-half pecks of seed wheat per acre has given the largest average yield for the several trials. It will be noticed that there is a lack of uniformity in the yield as compared with the rate of seeding, and during the entire trial the variation in that way has been noticed.

VARIETIES OF OATS.

Twenty-five varieties of oats have been grown in this trial during the past two years, and eight of them have been in the trial for six years or more. Several of the old varieties reported upon in Bulletin No. 39 have been discarded and a number of new ones added to the list.

In 1899 all varieties of oats were sown on May 8th and 9th at the rate of two and one-fourth bushels per acre. Harvesting began on August 2nd and was completed August 10th. None of the varieties were seriously injured by rust, there being only a trace of it visible, except with three varieties. The kinds which rustsed were Black Beauty, Tobolsk and Swedish Select. Archangel also rusted but to a less degree than the others.

In 1900 the oats were sown April 20th and 21st on fall plowed land, which grew wheat in 1899. The seed was treated with the standard formaldehyde solution, for smut, and the drill was set to sow three bushels of dry oats per acre, which made the actual rate of sowing two and one-half bushels of dry oats per acre. The grain came up well, but the drouth continued and the plants failed to stool properly, causing the stand to average thin on all plots. The straw made a very short growth, averaging from fifteen to eighteen inches in height for the early varieties and twenty-two to twenty-six inches for the later sorts. Rains in the early part of July came too late to save the crop, although late maturing varieties seem to have been benefitted to some extent, as shown by the smaller yields received from the early maturing sorts. The crop failed to ripen evenly and wet weather caused much loss and damage to the quality of the grain.

The 1900 crop was so inferior in growth and in the quality of grain produced that it was considered more nearly fair to use the descriptive notes taken for the crop of 1899, and they have been introduced into Table VIII.

TABLE VIII.—VARIETIES OF OATS.

Bulletin Number	Variety.	Where from	First crop grown at this station	Crop of 1899									Crop of 1900		Average yield per acre for two crops, 1899 and 1900
				Days maturing	Length of straw	Form of heads	Length of heads	Color of berry.	Size of berry	Shape of berry	Weight per bushel	Yield per acre, 1899	Weight per bushel	Yield per acre	
			Year		In.	Br'ch	In.				lb	bu.	lb	bu.	bu.
2	Archangel..............	College Farm.........	1892	85	49	whl'd	8	white	medium	shrt & plu'p	41½	69.1	37¾	23.9	46.5
12	Race Horse............	Maule................	1893	94	43	side	8	"	med. large	medium	39½	65.0	35	33.6	49.3
19	Black Beauty..........	N. B. & G. Co	1893	86	40	whl'd	7¼	brown	medium	"	37½	73.9	34½	19.0	46.5
26	Tartarian	Angell.................	1893	94	41	side	8	white	large	long & plu'p	39¼	65.0	34	34.9	50.0
35	American White Banner	Minn. Exp. Sta., originally from Maule.....	1894	89	42	whl'd	8	light br'ze	medium	medium	38½	74.3	36¼	25.9	50.1
39	White Russian..........	Minn. Exp. Sta	1894	94	40	side	8½	white	large	"	39	65.9	35	38.6	52.3
40	Lincoln	" " " originally from Angell....	1894	88	41	whl'd	7	light cre'm	medium	med. short	39¾	67.9	36¼	26.8	47.4
41	Lee Oats................	J. F. Lee, Fingal, N.D.	1897	90	36	side	7	dark br'wn	"	medium	36	57.7	35	34.6	46.2
42	U. S. No. 3..............	Russia, by U. S. Dept. Agriculture	1898	88	43	whl'd	8	light cre'm	medium	"	35¾	72.0	36¼	25.6	48.8
43	Danish Island..........	W. Atlee Burpee & Co.	1898	88	44	"	8	yel. & wh.	"	med. short	37½	66.8	37	26.6	46.7
44	Nameless White........	Salzer Seed Co	1898	85	50	whl'd	9	white	small	shrt & plu'p	44½	66.9	38½	22.0	44.5
45	Silver Mine.............	" " "	1898	87	44	"	8	"	med. large	medium	38½	81.1	39	23.2	52.2
46	Selected Black Beauty..	A selection from Black Beauty No. 19.......	1898	86	40½	"	8	dark br'wn	medium	medium	38¼	76.3	36½	15.4	45.9
48	The Lannii, U.S. No. 2963	Russia, by U. S. Dept. of Agriculture	1899	87	50	"	9	light cre'm	"	"	37	79.9	35¾	22.0	51.0
50	Tobolsk, U.S. No. 2800...	Russia, by U. S. Dept. of Agriculture.......	1899	87	45	"	8	"	"	shrt & plu'p	42¼	70.6	34½	21.9	46.3

TABLE VIII.—VARIETIES OF OATS.—Continued.

Bulletin Number	Variety	Where From	First crop grown at this station	Crop of 1899.									Crop of 1900		Average yield per acre for two crops, 1899 and 1900
				Days maturing	Length of straw	Form of heads	Length of heads	Color of berry	Size of berry	Shape of berry	Weight per bushel	Yield per acre, 1899	Weight per bushel	Yield per acre	
						Br'ch					℔	bu.	℔	bu	bu.
51	Swedish sel U.S. No. 2788	Russia, by U. S. Dept. of Agriculture	1899	88	46	wh'ld	8	white	medium	shrt & plu'p	39¾	75.4	38¼	23.0	49.2
52	German Rust Proof.....	Sioux Falls Seed Co..	1899	89	46	"	8	light cre'm	"	medium	37¼	78.2	36½	28.9	53.6
54	Sorted Tartarian.......	No. 26, hand picked...	1899	94	47	side	9	white	large	l'ng & plu'p	39	69.3	35	36.7	53.0
55	New Zealand............	Northrup, King & Co.	1899	94	47	"	9	"	"	long	38½	67.7	35	34.8	51.3
56	Bonanza King...........	L. L. May & Co.......	1899	88	46	wh'ld	8	"	"	l'ng & plu'p	38½	77.7	36½	34.9	56.3
58	Early Gothland, Min. 26	From Minn. Exp. Sta.	1899	88	43	"	8	"	"	"	38½	77.0	34¾	34.8	55.9
60	White Wonder, Minn 32	Minn. Exp. Sta........	1899	88	43	"	8	yel. & wh.	med. small	medium	37¾	75.6	36	27.4	51.5
61	White Russian, Minn. 35	Minn Exp. Sta........	1899	88	47	"	8¼	white	medium	med. short	38½	69.5	35¾	22.7	46.1
63	White Bronze...........	Washington Exp. Sta.	1899	89	42	"	7	light br'ze	"	medium	35½	68.8	35¼	40.3	54.6
64	Negro Wonder..........	Farmer Seed Co.......	1899	89	46	side	8½	dark br'wn	med. large	long	37¼	63.6	37	45.7	54.7
65	White Shonen...........	Farmer Seed Co.......	1899	88	45	wh'ld	8	light br'ze	medium	med. short	40½	67.1	37½	23.6	45.4
80	Mold's Black Beauty...	Northrup, King & Co..	1900	late	..	side	..	black	med. large	med. long	....	....	34½	33.0	

TABLE IX.—VARIETIES OF OATS GIVING LARGEST YIELDS IN 1900.

Bulletin No.	Variety	Yield per Acre Bushels	Weight per Bushel Pounds	Harvest Season
64	Negro Wonder	45.7	37	Med. late.
63	White Bronze	40.3	35¼	Med. late.
39	White Russian	38.6	35	Late.
54	Sorted Tartarian	36.7	35	Late.
26	Tartarian	34.9	34	Late.
56	Bonanza King	34.9	36½	Med. early
55	New Zealand	34.8	35	Late.
58	Early Gothland	34.8	34¾	Med. early
41	Lee's Black	34.6	35	Med. late.
12	Race Horse	33.6	35	Late.

TABLE X.—VARIETIES OF OATS GIVING LARGEST YIELDS IN 1899.

Bulletin No.	Variety	Yield per Acre Bushels	Weight per Bushel Pounds	Harvest Season
45	Silver Mine	81.1	38½	Early.
48	Thelannii	79.9	37	Early.
52	German Rust Proof	78.2	37¼	Medium.
56	Bonanza King	77.7	38½	Med. early.
58	Early Gothland	77.0	38½	Med. early.
46	Selected Black Beauty	76.3	38¼	Early.
60	White Wonder	75.6	37¾	Med. early.
51	Swedish Select	75.4	39¾	Med. early.
35	American White Banner	74.3	38½	Medium.
42	U. S. No. 3	72.0	35¾	Med. early.

The early maturing varieties yielded best in 1899. In 1898 the late varieties were the better yielders, and they were also the better yielders in 1900.

TABLE XI.—VARIETIES OF OATS GIVING LARGEST YIELDS, AVERAGE FOR SIX TRIALS, 1894, 1895, 1897, 1898, 1889, AND 1900.

Bulletin No.	Variety	Yield per Acre Bushels	Harvest Season
26	Tartarian	57.4	Late.
35	American White Banner	55.4	Med. early.
12	Race Horse	54.2	Late.
19	Black Beauty	53.5	Early.
2	Archangel	53.4	Early.
39	White Russian	51.8	Late.
40	Lincoln	51.6	Med. early

In comparing the yields of the several varieties for a series of years, the results seem to be somewhat in favor of the late maturing kinds as opposed to the early sorts. Those varieties, however, which are neither late nor early, but which have a medium harvest season are practically equal to the late sorts in the trials at this station, and such varieties would suffer less when the late oat growing season proves to be adverse.

VARIETIES OF BARLEY.

Twenty-five varieties of barley were grown in the field trial in 1899. The column headed "First Crop Grown at this Station" in the table tells when the seed was received and the column headed "Where From" indicates the source of the variety.

The grain was sown May 9th and 10th at the rate of two bushels per acre. No. 33 was received from the U. S. department of agriculture and had been badly injured by their treatment for destroying insects and disease germs. Harvesting began July 21st and was completed August 2nd (except No. 33 which was not ripe until August 14th.) The column in the table marked "Days Maturing" will indicate which varieties ripen early and which are late in maturing.

In 1900 the trial with barley varieties was conducted in the same field and under similar conditions to those already described for the trials with the varieties of oats. The growth of straw was thin and short, the height ranging from ten to twenty inches, the early maturing sorts giving a much poorer growth and a lighter yield than the late varieties. The varieties were sown on April 23rd and 24th, while harvesting was begun on July 14th and completed on August 3rd. Table XII gives the results of the two years' trial, the descriptions being for the crop of 1899.

TABLE XII.—VARIETIES OF BARLEY.

Bulletin No.	Variety	Where from	First crop grown at this station.	Crop of 1899									Crop of 1900		Average yield per acre, two crops
				Days maturing	Length of Straw	Length of head.	No. of rows per head	Length of beards	Size of berry	Color of berry	Weight per bushel	Yield per acre	Weight per bushel	Yield per acre	
			Year		In.	In.		In.			Lb.	Bu.	Lb.	Bu.	Bu.
4	Champion of Vermont..	Thorburn	1893	76	28	2¾	2	4½	Medium	Med. dark...	50½	42.7			
6	Chevalier	Salzer..................	1893	82	34	2¾	2	5	Large	Light	49¼	49.0			
7	Mansury	N., B. & G. Co...........	1893	82	35	2¾	2	5	Med. large...	Yellow	50½	46.1	46	16.8	31.5
10	Highland Chief.........	Maule..................	1893	84	34	3	2	5	Medium	Light	51	42.7			
12	Highland Scotch	Angell..................	1893	84	33	3½	2	4½	Medium	Light	51	45.2			
19	Success.................	Minn. Exp. Station.....	1893	84	33	3	2	5	Med. large...	Light	50½	47.2	47	25.8	37.5
20	Hoover's Hulless.......	Bisbee, N. D............	1893	73	..	.....	..	.....	Medium	Med. dark...	56	25.4			
21	McEwan Hulless........	Park River, N. D.......	1897	72	25	2⅞	2	5	Med. large...	Dark	59½	38.2	56	13.0	25.6
22	U. S. No. 5..............	Russia, by U. S. Dept. of Agriculture........	1898	75	32	2	6	3½	Medium	Light........	48¼	44.1	43½	12.7	28.4
23	Dakota Silver Beard-less,..................	....	1898	75	34	2¼	6	.....	Medium	Med. dark...	48½	39.5	42¾	13.8	26.7
24	Salzer s Silver King....	Salzer Seed Co.........	1898	75	33	2⅜	6	3½	Medium	Light........	49½	44.7	42¼	11.2	27.9
25	Minn. No. 6, Mansury...	Minn. Exp. Station.....	1898	77	32	2¼	6	3½	Med. large..	Light........	49½	50.3	40½	12.5	31.4
26	Minn. No. 7, Champion of Vermont	Minn. Exp. Station.....	1898	76	29	2½	2	5	Med. large ..	Dark	50¾	40.6	43	10.6	25.6
27	Minn. No. 15, French Chevalier	Minn. Exp. Station.....	1898	83	29	2¾	2	4½	Med. large ..	Med. dark. .	51	50.6	50	20.2	35.4
28	Minn. No. 21, Odessa....	Minn. Exp. Station.....	1898	75	32	2	6	3½	Medium	Yellow.......	49¼	49.1	40½	13.0	31.0

TABLE XII.—VARIETIES OF BARLEY.—Continued.

Bulletin No.	Variety	Where From	First crop grown at this station	Crop of 1899									Crop of 1900		Average yield per acre, two crops
				Days maturing	Length of straw	Length of heads	No. of rows per head	Length of beards	Size of berry	Color of berry	Weight per bushel	Yield per acre	Weight per bushel	Yield per acre	
					In.	Br'ch	In.	In.			Lb.	Bu.	Lb.	Bu.	Bu.
29	Minn. No. 28, Bernard's.	Minn. Exp. Station.....	1898	73	32	2½	6	4½	Medium	Light........	49¾	42.4	44½	12.2	27.2
30	Minn No, 86, Culver's..	Minn. Exp. Station.....	1898	85	34	3½	2	5	Med large..	White	50	49.2	45½	25.4	37.3
31	Minn. No. 100, Houston's Golden Queen.........	Minn. Exp. Station.....	1898	77	33	2¼	6	4	Medium	Light........	49	46.5	44½	11.4	28.9
32	Sisolsk, U. S. No. 2962..	Russia, by U. S. Dept. of Agriculture........	1899	75	33	2⅝	6	4½	Med. large..	White	45¼	52.1	43¼	14.1	33.1
33	Kostroma, U. S. No. 2793.	Russia, by U. S. Dept. of Agriculture........	1899	94	31	2½	2	6	Med. large..	Dark	48⅜	28.1	47¼	20.2	24.2
34	Salzer's Beardless......	Salzer Seed Co..........	1899	71	28	2	6	.....	Med. large..	Dark	44⅜	43.1	37	8.9	26.0
35	White Hulless..........	Northrup, King & Co...	1899	72	25	1¾	6	.....	Medium	Med. dark...	56½	32.7	52	6.1	19.4
36	Minn. No. 6, Mansury...	Minn. Exp Station.....	1899	76	33	2½	6	3½	Med. large..	Light ......,	50¼	54.3	42	12.2	33.2
37	Minn. No. 27, Success...	Minn. Exp. Station.....	1899	71	28	2⅛	6	.....	Medium	Med. dark...	44¼	36.1			
38	Minn. No. 105..........	Minn. Exp. Station.....	1899	76	33	2⅜	6	4	Medium	Yellow	48	50.6	41	17.2	33.9
39	English	G. Cooper, Gardner, N. D......................	1899	*	..	.....	2	.....	Large	Yellow	....	....	47½	13.6	
40	Turkestan Hulless, U. S. No. 977............	U. S. Dept. of Agr......	1899	†	..	.....	6	.....	Large	Yellow	....	....	....	11.4	
41	Minn. No. 6, Mansury...	Minn. Exp. Station.....	1900	..	..	.....	6	.....	Med. large..	Yellow	....	....	40	11.6	
42	New Beardless..........	N., King & Co..........	1900	*	..	.....	6	.....	Medium	Yellow	....	....	36¼	8.6	

*Early. †Late.

TABLE XIII.—VARIETIES OF BARLEY GIVING LARGEST YIELD IN 1900.

Bulletin No.	Variety	Weight per bushel	Yield per acre	Harvest season
		lb	bu.	
19	Success	47	25.8	Late
30	Culver's	45½	25.4	Late
33	Kostroma	47½	20.2	Late
27	French Chevalier	50	22.2	Late
38	Minnesota No. 105	41	17.2	Med. early
7	Two-rowed Mansury	46	16.8	Late
32	Sisolsk	43¼	14.1	Med. early
23	Dakota Silver, Beardless	42¾	13.8	Med. early
39	English	47½	13.6	Late
21	McEwan Hulless	56	13.0	Early
28	Odessa	40½	13.0	Early

TABLE XIV.—VARIETIES OF BARLEY GIVING LARGEST YIELDS, AVERAGE FOR TWO YEARS, 1899 AND 1900.

Bulletin No.	Variety	Yield per acre	Harvest season
		bu.	
19	Success	37.5	Late
30	Culver's	37.3	Late
27	French Chevalier	35.4	Late
38	Minnesota No. 105	33.9	Med. early
36	Mansury	33.2	Med. early
32	Sisolsk	33.1	Med. early
7	Two-rowed Mansury	31.5	Late
28	Odessa	31.0	Early

TABLE XV.—VARIETIES OF BARLEY GIVING LARGEST YIELDS, AVERAGE FOR THREE YEARS, 1898, 1899 AND 1900.

Bulletin No.	Variety	Yield per acre	Harvest season
		bu.	
27	French Chevalier	39.4	Late
30	Culver's	38.9	Late
25	Mansury	37	Med. early
28	Odessa	37	Early
24	Salzer's Silver King	34.6	Med. early
29	Bernard's	34.4	Med. early

The late maturing varieties of barley gave enough heavier yield in 1900 to affect the average yield for three years to such a degree as to cause the late kinds to rank highest. In considering that average the unusual and extreme conditions of the past season should be kept in mind, as such seasons in the past have been very rare.

Early maturing barley has an advantage in being harvested and off of the ground early, which permits early plowing of the land with partial summer fallow effect.

VARIETIES OF SPELT.

Four varieties of spelt were sown in the field trial in 1899. Of these Nos. 3 and 4 came directly from Russia, and contrary to our experience in 1898 both produced good crops, No. 3 giving a larger yield than the old home grown seed, (No. 2).

The grain was sown May 10th. The drill was set to sow two and one-half bushels of barley per acre, except for No. 3, which was sown at the rate of two and three-fourths bushels of barley per acre on account of having a larger berry. None of the grain was sown thick enough. The trials at this station indicates that the drill should be set to sow two and one-half to three bushels per acre of oats to seed spelt thick enough. It does not seem to tiller or stool as much as the other grains do. The varieties were all harvested August 5th. Table XVI gives the results in detail.

TABLE XVI.—VARIETIES OF SPELT—CROP OF 1899.

Bulletin No.	Variety	Where from	First crop	Days matur'g	Height	Length of Heads	Weight per bushel	Yield per acre
			Year		in.	in.	lb	bu.
*1	U. S. No. 4.....	Russia..........	1898	86	39	1¾	32½	52.7
†2	Common.......	G. A. Welch, Bismarck, N.D.	1897	86	37	1⅝	37½	69.1
3	Yaroslaf, U. S. No. 2789.......	Russia	1899	87	37	1¾	37½	74.1
4	Ufa, U. S. No. 2959...........	Russia.........	1899	87	42	2	....	52.6

Spelt weighs about the same as oats and is calculated above on the basis of thirty-two pounds per bushel. No. 2 yielded 2338

* This variety is published in bulletin No. 39 as No. 106.

† This variety is published in bulletin No. 39 as No. 305.

pounds per acre in 1898. This makes an average for the two years of 2274 pounds or 71.1 bushels per acre.

SPELT IN 1900.

Only the two best yielding varieties were continued in the trial in 1900.

The seed was treated with formaldehyde for smut and sown April 25th at the rate of two and one-half bushels of dry grain per acre. The grain came up well and made a fair stand. It was ripe and harvested July 30th, requiring about the same period for growth as the medium late varieties of oats and barley.

The yield was as follows:

Common spelt No. 2—32.69 bushels per acre.

Yaroslaf Spelt No. 3—28.56 bushels per acre.

The average height of straw was twenty-one inches and the average weight of the grain per bushel was thirty-nine pounds. Common spelt had the longer straw by two inches and produced slightly larger heads, while the grain weighed two pounds more per bushel than that from the Russian (Yaroslaf) seed.

It will be interesting to notice the comparative yields of spelt, barley and oats in the dry season of 1900. As already noted in the discussion under varieties of oats and barley, the season of ripening in the crop of 1900, seemed to be, to a large extent, the determining factor in the yielding capacity of the several varieties. In the comparison given below, the average yield of the spelt is compared with the average yield of ten varieties each of oats and barley, the periods of growth for which are practically equal to that of the spelt.

Average yield of spelt—980 pounds per acre.

Average yield of barley—844 pounds per acre.

Average yield of oats—1058 pounds per acre.

Of the three grains, oats gave a little the best yield and barley the poorest in the crop of 1900. As an average for three crops, 1898 to 1900 inclusive, the results are as follows:

Average yield of spelt—1,843 pounds per acre.

Average yield of barley—1,770 pounds per acre.

Average yield of oats—1,798 pounds per acre.

In the above comparison the average yield of the best producing varieties of barley and oats, according to the results obtained from a three year's trial, and the yields secured from the best producing spelt at the station are compared. It will be noticed that the spelt ranks first with an advantage of forty-five pounds over the oats while barley yields seventy-three pounds less than the spelt.

VARIETIES OF MILLET.

Thirteen varieties of millet were grown at this station in 1899. The seed was sown June 7th and 8th. The drill was set to sow three pecks of flax per acre. There is a marked difference in the size of the seed of the different varieties of millet so that the actual rate of seeding was not the same for each variety. The size of the seed is noted in Table XXIII together with the other results of the trial.

German millet No. 10 (southern grown seed) did not mature seed. Samples of seed of the other varieties were saved and planted June 5th, 1900 on fall plowed land, which had been cultivated and kept in good condition after it had become fit to work in the spring. A strain of Siberian millet (No. 20) and a new sample of southern grown German millet (No. 19) were also included in this trial.

Drouth injured the early maturing sorts, and especially those of the broom-corn type. The later kinds did well, having been favored by the rains.

German millet No. 19 was harvested September 11th—ninety-eight days after planting. It had made a heavy growth of leafy fodder, yielding over five tons of hay per acre, but it was only beginning to ripen seed when cut.

German millet No. 6 has been grown at this station since 1896. German millets Nos. 10 and 19 were samples of southern grown seed planted for the first time in North Dakota in the years noted. The millet from the southern grown seed, makes a heavy growth of fodder, but produces few heads and is not inclined to mature seeds in this latitude except during long seasons. A comparison of the crops for the two years, from the two kinds of seed gives the following:

Average yield per acre, North Dakota seed..	5349	2195
Average yield per acre, southern grown seed..	8450	105
Difference	3101	2090

TABLE XVIII.—VARIETIES OF MILLET.

Bulletin Number	Variety	Where from	Crop of 1899								Crop of 1900		Avg. 2 crops	
			Days maturing	Height of straw	Yield of straw per acre	Kind of heads	Color of seed	Size of seed	Weight per bushel	Yield per acre	Straw per acre	Seed per acre	Straw per acre	Seed per acre
				in.	℔				℔	bu.	℔	bu.	℔	bu.
6	German	College Farm..............	82	37	6670	fox tail	light yel.	med.	53¾	35.9	4.028	51.9	5,349	43.9
7	Early Fortune......................	Sioux Falls Seed Co.......	80	28	5611	close br	red	large	54¾	9.9	......	32.9	......	21.4
8	New Siberian.......................	" " " "	85	37	5644	fox tail	light red	med.	40	16.2	5,659	30.3	5,651	23.2
9	Common	Northrup, King & Co......	78	35	5021	"	light yel.	"	52	33.4	......	37.2	......	35.3
10	German (southern grown seed)....	" " "	142	39	6621	"	didn't m	at. seed						
11	Blk Voronezh broom-corn, U. S. 2795	Russia, by U. S. Dept. Agr.	79	36	4910	loose br.	glossy br	large	58½	34.2	......	32.1	......	35.3
12	Hog	Northrup, King & Co......	78	36	4814	close br.	light yel.	med. lg	57½	30.6	......	30.0	......	30.3
13	Hungarian..........................	" " "	85	33	6524	fox tail	light gr.	small	41½	15.6	6,386	33.7	6,455	24.6
14	Earliest Russian...................	Salzer's Seed Co...........	85	37	6568	"	....	med.	39	11.9	6,372	30.9	6,470	21.4
15	Tambov broom-corn, U. S. No. 2794.	Russia, by U. S. Dept. Agr.	71	40	3835	loose br.	red	large	51½	47.0	2,650	33.8	3,243	40.4
16	Red Voronezh broom-corn, U.S 2796	" " " " "	66	39	3134	broom	"	"	53½	38.4	1,485	15.5	2,320	26.9
17	Red Russian broom-corn, U. S. 2797.	" " " " "	71	40	3948	loose br.	"	me. lge	56	45.8	2,371	36.6	3,160	41.2
18	Red Orenburg broom-corn, U.S. 2960	" " " " "	...	37	4928	close br.	"	large	56½	42.7	2,223	32.2	3,575	37.4
19	German, (southern grown seed)....	Northrup, King & Co......	...	44	....	fox tail	light gr.	small	39	....	10,279	4.1	*8,450	2.0
20	Siberian...........................	" " "	88	40	....	"	yelsh red	med.	46	....	5,561	23.0		

*Average of No. 10 and No. 19.

The North Dakota seed has given one and one-half tons less fodder, but over a ton more grain than the southern grown seed. It is observed that as millet becomes acclimated here it tends to mature earlier, and to produce more seed. The good condition for growth late in the season of 1900 favored the late maturing, southern grown millet seed and has made the average difference in hay yield for the two years greater than should be expected for the average season.

In order to compare the yields of grain for millet, oats and barley, the average yield of the three best producing varieties in each class for the years 1899 and 1900 are given below:

Average seed yields per acre......	2092 lbs.
Millet	2092 lbs.
Oats	1780 lbs.
Barley	1763 lbs.

FLAX EXPERIMENTS.

The flax trial of varieties in 1899 was made upon fall plowed land, which had produced a crop of wheat in 1898. The flax was sown at the rate of three pecks per acre, on May 15th. The Riga fiber flax was in nearly full blossom June 30th and averaged twenty inches high, while the other varieties were only fourteen to fifteen inches high and had only a few blossoms.

In 1900 the trial was made on ground which grew wheat in 1899. The land was plowed in the spring and harrowed thoroughly, kept free from weeds and covered with a good soil mulch until seeded, May 16th. The flax came up at once making a good even stand. Table XVII gives the results of the trials.

TABLE XVII.—VARIETIES OF FLAX.

Bulletin No.	Variety	Where From	Crop of 1900					Crop of 1899		Average for 3 Crops, 1898, 1899 and 1900	
			Days Maturing	Length of Straw	Weight per Bushel	Seed per Acre	Straw per Acre	Seed	Straw	Seed	Straw
				In.	Lb.	Bu.	Lb.	Bu.	Lb.	Bu.	Lb.
*5	Riga Fibre	J. C. Swan	77	24	52½	10.6	1683	14.1	2393	14.1	2348
*6	Common	Fargo, North Dakota	90	18	53¼	11.2	1164	18.6	2500	16.5	2070
*7	Russian	Salzer's Seed Co	78	20	53½	16.0	1515	19.0	2235		
8	Odessa	Fleming	90	18	52½	12.1	1322				

*In Bulletin No. 39, No. 5 was published as No. 306, No. 6 as No. 307 and No. 7 as No. 155.

The tabular statement shows a marked difference in the number of days required for maturing different varieties in the season of 1900. That difference is in part due to several days of wet weather which occurred between the days of cutting the early and late kinds. In 1899 Riga fiber flax ripened nine days and Russian flax two days earlier than the common sort obtained from local sources.

The Riga fiber flax produces a long straight straw with few branches. It yields less seed but more straw than the seed flax, and experts say that it yields more and a better quality of fiber for linen manufacture, than does common flax.

In the trial of 1899, the flax plots extended across a strip of ground which had been manured heavily in the fall of 1897. The ranker growth of the flax on this part of the plot was very noticeable thoughout the season. It came up more quickly, branched stronger, blossomed earlier and more profusely, grew two to four inches higher and ripened two or three days earlier than the flax on the unmanured ground. The crop was estimated as one-eighth greater both in seed and straw on the manured ground.

FLAX AND WHEAT MIXED.

A three years' trial of sowing flax and wheat together has been made. In the trials in 1898 and 1899, the wheat and flax were sown at the same date and at the rate of one bushel of wheat and two pecks of flax per acre. Both grains were sown with a shoe drill, the wheat having been drilled first and the flax afterward, in parallel drill rows.

In practice it is the custom to cross drill the flax, but the small trial plots used in these experiments made that method impracticable.

In 1898 owing to an oversight the plot was not sown until May 31st, too late in the season to produce a good crop. In 1899 the seeding was done by May 15th. The flax ripened a few days earlier than the wheat in 1898 and at the same time as the wheat in 1899. The following tabular statements show the results obtained from two crops

Yield of wheat in 1898	11.1
Yield of wheat in 1899	18.9
Average for the two years........	15.0
Yield of flax in 1898	3.8
Yield of flax in 1899	4.0
Average for the two years	3.9

In 1899 plots of the same variety of wheat adjacent to the one which grew flax and wheat and sowed at the same time, yielded twenty-two and five-tenths bushels per acre. A similar plot of flax of the same variety as that grown with the wheat yielded eighteen and six-tenths bushels per acre. Allowing 60 cents a bushel for the wheat and 90 cents for the flax gives the following:

Wheat alone	$ 13.50
Flax alone	16.74
Average	$ 15.12
Wheat and flax grown together....	14.94
Difference in favor of unmixed grain	$ .18

The wheat grown with the flax graded No. 2 northern, eighty per cent hard. It was badly bleached. That grown alone graded No. 2 northern, ninety-five per cent hard. Both were subject to the same weather conditions and were threshed on the same day. The flax grown alone weighed fifty-one and one-half pounds per bushel. That grown with wheat weighed fifty-three pounds per bushel, and was cleaner than that grown alone.

It is the common practice when the method of sowing wheat and flax together is followed to sow the flax a week or ten days later than the wheat—about the time wheat is coming up.

In order to secure data upon the relative time and quantity to sow of these grains when they are grown as a mixed crop, the following experiments were begun in 1900. This trial includes six different rates of seeding. The wheat was sown upon all of the plots on the same day. Two plots were seeded to flax as soon as the wheat was in, others were seeded ten days later, and two plots were seeded fifteen days after the wheat was sown. The plan of the experiment together with the data obtained is shown in Table XVIII.

FLAX AND WHEAT, CROP OF 1900.

TABLE XVIII.—SHOWING PLAN OF EXPERIMENTS AND RESULTS.

Plot No.	Crop	Date Sown	Rate per Acre Peck	Date Ripe	Stand	Height of Straw Inches	Yield per Acre Bushels	Weight per Bushel Pounds
1	Wheat..... Flax.......	May 5.... " 5....	4 2	Aug. 1... " 2...	⅝ ⅜	26 13	13.65 1.79	60½ 54¼
2	Wheat..... Flax.......	May 5... " 16...	4 2	Aug. 4... " 4...	¾ ⅜	33 18	19.56 1.64	56¼ 50¼
3	Wheat..... Flax.......	May 5.... " 5....	3 2	Aug. 1... " 2...	⅜ ½	25 13	9.28 1.66	60 54½
4	Wheat..... Flax.......	May 5... " 16...	3 2	Aug. 3... " 3...	⅜ ½	27 13	12.67 1.60	59 55¼
5	Wheat..... Flax.......	May 5... " 21...	3 2	Aug. 3... " 5...	⅞ 1–10	29½ 15½	15.53 .31	57½
6	Wheat..... Flax.......	May 5... " 16...	2 2	Aug. 3... " 3...	½ ¼	26 14	11.46 1.23	58¼ 54½
7	Wheat..... Flax.......	May 5... " 21...	2 2	Aug. 3... " 5...	¾ 1–10	29 15	15.82 .37	57½
8	Wheat..... Flax.......	May 5... " 16...	4 1	Aug. 3... " 4...	¾ 1–25	30 14	16.28 .43	57
9	Wheat..... Flax.......	May 5... " 16...	3 1	Aug. 4... " 4...	⅝ ⅜	30 17	15.70 1.35	57¾ 53¾
10	Wheat..... Flax.......	May 5... " 16...	2 1	Aug. 3... " 3...	½ ⅜	28 14	12.21 1.10	58¼ 53

The grain was harvested from all the plots on August 2nd. The wheat was all ripe enough to cut upon that date, but some of the flax was too green, as may be seen by referring to Table XVIII. In the column marked "stand" the figures given are judgments from observations at the time of harvest. In the case of flax the per cent of a stand was evidently placed too high, as is shown by the yield of seed obtained. The yields both of flax and wheat are based on the weight of the clean grain, as it was separated by the fanning mill. It will be noticed that the yield of flax is comparatively small from all of the plots.

Comparing the yields from the plots which were subjected to the different rates of seeding gives the following:

Plot Number	2		4		6		8		9		10	
Kind of Grain	Wheat	Flax	Wheat	Flax	Wheat	Flax	Wheat	Flax	Wheat	Flax	Wheat	Flax
Rate of seeding per acre........	pk. 4	pk. 2	pk. 3	pk. 2	pk. 2	pk. 2	pk. 4	pk. 1	pk. 3	pk. 1	pk. 2	pk. 1
Yield per acre ...	bu. 19.56	bu. 1.64	bu. 12.67	bu. 1.60	bu. 11.46	bu. 1.23	bu. 16.28	bu. 0.43	bu. 15.70	bu. 1.35	bu. 12.21	bu. 1.10

Sowing four pecks of wheat and two pecks of flax per acre has given the largest yield both of wheat and flax in the above experiment. It should be observed, however, that this is the result of a single trial in a very dry season when grain stooled poorly. In a favorable season thinner sowing would probably give more favorable results.

Comparing the average of the yields from plots 1 and 3 upon which the flax and wheat were sown at the same date with the average yield from plots 2 and 4 upon which the flax was sown ten days later than the wheat, the following results are noted:

Wheat and flax upon the same date	11.47	1.73
Flax sown ten days later than wheat	16.12	1.62
Difference in favor of sowing the flax ten days later than the wheat	4.65	0.11

Comparing the average yield from plots 2 and 6 with that from plots 5 and 7 gives the following results:

Flax sown ten days later than wheat	12.07	1.42
Flax sown fifteen days later than wheat	15.68	0.34
	+3.61	—1.08

Sowing the flax fifteen days later than the wheat has not injured the wheat crop but has given practically no flax at all.

These results seem upon the whole to favor sowing the flax a week or ten days later than the wheat. The cultivating which the wheat received caused a ranker growth and larger yield. In the above trial the wheat was two inches high ten days after it was sown and to prevent injury, the drill chains were not allowed to drag when the flax was sown. It might be better to sow the flax just before or as the wheat was coming up, when the chains could be allowed to drag, which would give the ground more cultivation and cover the flax seed better.

Flax and wheat grown together on very rich land made a better showing than they did on ordinary soil. The flax made a

rank growth and acted as a support for the wheat plants. It would seem, therefore, that upon very fertile soil where wheat is likely to grow rank and lodge that the two grains may be profitably grown together, but on ordinary land which is only fertile enough to produce one good crop of wheat or flax in a season, these trials indicate that nothing is gained by attempting to produce two crops on the same ground at the same time.

The writers wish to call attention to the fact that this trial has not extended through a very long time, and that the season of 1900 was a very unusual one, and that in consequence these indications should not be taken as final.

QUANTITY OF FLAX SEED PER ACRE.

Riga fiber flax was used in this experiment, the chief object being to learn the effect of thick and thin sowing of flax upon the yield and quality of the straw and fiber. The flax followed wheat each year and was sown on May 15th in 1899, and on May 16th in 1900. It was sown with a shoe drill, in drill rows six inches apart. In each trial the ground was fall plowed and was thoroughly harrowed and kept in good condition and free from weeds until the flax was sown. Table XIX gives some of the data obtained.

TABLE XIX.—FLAX FIBER—DIFFERENT QUANTITIES OF SEED PER ACRE.

Plot Number	Seed per Acre	Crop of 1899.						Crop of 1900		Average Two Crops	
		Stand	Days Maturing	Heighth of Straw	Weight per Bushel	Grain per Acre	Straw per Acre	Grain per Acre	Straw per Acre	Grain per Acre	Straw per Acre
	pks.			In.	Lb.	Bu.	Lb.	Bu.	Lb.	Bu.	Bu.
1	2	Good	79	31½	53¼	14.2	2386	10.3	1697	12.3	2041
2	3	Good	79	30½	53	14.1	2393	10.6	1683	23.3	2038
3	4	Good	79	29½	53½	15.1	3272	10.7	1541	12.9	1957
4	5	Thick	79	29½	54¾	15.0	2345	10.8	1600	12.9	1972
5	6	Thick	79	28½	54¼	15.3	2289	10.8	1879	13.0	2084
6	7	Thick	79	28	54	14.8	2112				
7	8	Very thick	79	28	54	15.1	2441	12.5	1784	13.8	2113
8	10	Very thick	79	26½	53¼	14.7	2220	11.8	1753	13.3	1987
9	12	Very thick	79	26	53½	12.0	2660	8.3	1680	10.1	2170

In the above trial there appears to be no regularly marked difference in the yield of either the seed or straw. The thin sown flax grew the heaviest and longest straw, but it had more branches and less of long straight straw than the thick sown flax.

TABLE XX.—SEED FLAX—DIFFERENT AMOUNTS OF SEED PER ACRE—CROP OF 1900.

Plot number	Seed per acre	Stand	Days maturing	Height of straw	Wheat per bushel	Quality of Seed	Grain	Straw
	pk.			in.	lb	per cent	bu.	lb
1	1	5/8	92	21	52¼	85	12.9	1623
2	2	4-5	90	16½	52¾	85	12.7	1283
3	3	9-10	90	16	52¾	82	10.3	1210
4	4	good	90	16	53	87	13.8	1362
5	5	thick	90	17	52¾	85	16.8	1743
6	6	"	91	17½	50¾	75	15.5	1345

In 1900 a trial was made in which Odessa flax No. 4 was sown at different thicknesses to learn the effect on the yield and quality of the seed. The ground used for this trial grew flax in 1899, was fall plowed and kept cultivated in the spring until the flax was seeded. Table XX gives the data obtained.

No conclusion can be drawn from this single trial. In the dry season of 1900 the thick seeding, viz: four to six pecks per acre, gave larger yields and a relatively greater profit than the thinner sowing. Two to three pecks per acre is our usual rate of seeding flax on the station farm.

VARIETIES OF BUCKWHEAT.

Six varieties of buckwheat were grown in the comparative trial in 1899. Five of these were tested in 1898. No. 6 was received from the U. S. department of agriculture, and came direct from Russia. All of the varieties were sown June 7th, with the shoe drill, set to sow five pecks of wheat per acre.

All of the varieties made a rank growth and blossomed freely all through the summer, but few of the blossoms fertilized and produced berries. The two Russian varieties seem to be best adapted to our conditions.

The scarcity of bees in this locality may be the cause of the poor fertilization of the blossoms.

Table XXI submitted herewith gives the data recorded.

TABLE XXI.—VARIETIES OF BUCKWHEAT, CROP OF 1899.

Bulletin Number	Variety	Where From	Days Maturing	Height of Straw	Berry: Color	Berry: Size	Weight per Bushed	Yield per Acre	Average Yield for 1898 and 1899
				In.			Lb.	Bu.	Bu.
†1	Russia, U. S. No. 2	Russia, by U. S. Dept. of Agriculture	69	31	Brown	Medium large	43½	*21.1	23.5
†2	Silver Hull	W. Atlee Burpee & Co	81	40	Silver Gray	Medium	46	11.2	15.2
†3	New Japanese	W. Atlee Burpee & Co	84	47	Brown	Medium large	43¾	19 8	25.0
†4	Calcutta	Salzer Seed Co	81	46	Silver Gray	Medium small	50¼	18.9	20.9
†5	Common	Salzer Seed Co	84	46	Brown	Large	42½	17.2	18.2
6	Orenburg U. S. No. 2801	Russia, by U. S. Dept. of Agriculture	70	36	Brown	Medium large	•45¾	30.0	

*42 pounds per bushel.
†These varieties are published in Bulletin No. 39, under other numbers as follows: No. 1 as No. 101, No. 2 as No. 141, No. 3 as No. 142, No. 4 as No. 151, No. 5 as No. 153.

A Russian variety, No. 6 introduced by the U. S. department of agriculture gave the largest yield and is the most promising of any variety tried at this station.

Only two varieties of buckwheat were sown in 1900. Russian No. 1 and Orenberg No. 6. The ground used grew turnips in 1899, and was fall plowed. It was cultivated early in the spring and was clean and in good condition, when the buckwheat was sown, June 5th. The grain came up quickly, grew rapidly and blossomed freely. The crop was harvested August 30th, at which time there were many blossoms and only two-thirds of the kernels were mature; although some of the grain had become ripe and shelled out and fallen to the ground. The straw stood thirty inches high at harvest time. The yield of Orenberg was twenty-four bushels per acre. By reason of an accident the yield of the other variety was not obtained, but field inspection indicated that it was as good as Orenburg.

A TRIAL OF VARIETIES OF POTATOES.

Forty varieties of potatoes were grown in the trial in 1899. Twelve of these, Nos. 39 to 51 inclusive, were grown in 1898. The others were secured from the various seedsmen named in the column marked "Where From," being the kinds, generally, which were the most highly advertised. The seed was cut two to three eyes to the piece and planted by hand in furrows about four inches deep and three feet and four inches apart. The hills were two feet apart in the row. All the varieties were planted May 19th and 20th.

TABLE XXIV.—VARIETIES OF POTATOES.

Bulletin number	Variety	From Where	Stage of maturity at frost, Sept. 17	No. of hills harvested	Average size of tubers	Shape	Color	Depth of eyes	Fingers and toes	Mealiness	Flavor	Yield per acre	Marketable	Small	Scabby	Per cent frozen
									Per ct	Per ct	Per ct	Bu.	Per ct	Per ct	Per ct	
†39	Early Andes	H. C. Marsh	4-5 ripe	158	large	oval obl'ng	russ't red	shallow	1	95	90	204.5	76	9	10	5
†40	Early Dawn	H. C. Marsh	¾ ripe	154	med. large	"	russet	medium	10	85	90	201.9	62	5	27	6
†41	Burpee's Extra Early	W. Atlee Burpee & Co.	nearly gr.	167	med. small	long oval	lgt russet	med. deep	1	85	85	149.9	78	9	10	3
†42	True Early Rose	" " "	"	158	medium	"	red "	medium	2	85	85	208.3	75	11	9	5
†43	Carman No. 1	" " "	"	167	med. large	oval	white	"	..	90	85	200.5	87	6	7	0
†45	Early Beauty of Hebron	" " "	⅔ ripe	163	large	med. lg. ov.	rd. russet	med. deep	2	70	75	205.8	59	13	22	6
†46	Burpee's Superior	" " "	nearly gr.	164	"	long oval	white	medium	5	85	85	236.0	80	11	5	4
†47	Rural New Yorker No. 2	" " "	green	170	medium	oval	"	shallow	..	75	80	182.2	96	3	1	
†48	Six Weeks	J. A. Salzer Seed Co.	⅞ ripe	156	large	long oval	russet	medium	3	80	75	182.7	68	7	19	6
†49	Early Ohio	Exp. Station Farm	4-5 ripe	160	med. large	oval obl'ng	rd. russet	med. shalw	..	95	90	173.0	63	8	20	9
†50	World's Fair	L. L. Olds	1-5 ripe	170	medium	oval	white	shallow	2	90	95	210.6	78	12	8	2
51	Joseph	" "	nearly gr.	158	large	oblong flat	rd. russet	deep	2	90	75	187.7	92	7	1	
52	Early Minn	Northrup, King & Co.	"	167	med. small	med. long	russet	medium	5	95	90	167.7	77	15	6	2
53	Early Fortune	" " "	"	168	small	l'ng & irreg	rd. russet	"	1	95	90	207.8	74	14	10	2
54	Pingree	" " "	green	171	medium	long oval	light "	med. shalw	4	75	80	204.3	86	9	5	
55	Freeman	" " "	very green	168	"	oval	white	medium	..	80	80	201.5	91	6	3	
56	Triumph	" " "	ripe	164	"	round	red	"	..	70	70	142.0	84	8	7	1
57	Montana Rose	" " "	⅔ ripe	169	med. large	long	rd. russet	med. deep	1	75	75	125.0	78	5	2	15
58	N. K. & Co's Ext. Early Oh.	" " "	¾ ripe	170	"	obl'ng oval	"	med. shalw	1	80	80	220.5	75	5	10	10
59	N. K. & Co's Ideal	" " "	green	168	"	"	lgt russet	medium	1	85	80	202.7	90	6	4	
60	Early Mayflower	Sioux Falls Seed Co.	¾ ripe	169	"	"	russet	shallow	..	80	80	205.3	64	8	23	5
61	American Wonder	Salzer Seed Co	nearly gr.	169	med. small	long	lgt russet	medium	3	60	60	140.2	89	7	4	
62	Wonderful Harvest King	" "	green	154	med. large	oval flat	white	med. deep	..	85	75	149.1	94	2	3	1
63	Salzer's Earliest	" "	ripe	165	medium	round	red	"	..	65	70	151.2	95	2	1	2
64	Sharff's Early Dakota	" "	¾ ripe	125	med. small	long	lgt russet	medium	5	65	65	53.1	32	6	50	12
65	Free Silver	" "	very green	161	med. large	oval	light	"	..	65	70	171.2	94	33	3	
66	Iron Clad	" "	nearly "	167	"	long	lgt russet	shallow	..	70	70	157.1	84	12	2	2
67	Secretary Wilson	" "	3-5 ripe	169	medium	long oval	white	med. deep	3	85	90	222.1	70	7	16	7
68	Algona	" "	nearly gr.	169	"	long	"	med. shalw	5	85	75	185.6	82	8	9	1
69	Hundred Fold	" "	green	163	"	oval	"	shallow	..	75	80	183.7	90	7	3	

70	McKinley	Salzer Seed Co.	nearly gr.	171	medium	lg. & irreg.	white	medium	10	80	95	218.7	70	4	24	2
71	Early Michigan	" " "	⅔ ripe	165	"	"	rd. russet	"	..	80	80	175.3	70	13	10	7
72	Senator	L. L. May & Co.	¾ ripe	164	"	oval obl'ng	"	"	..	85	75	195.9	58	7	30	5
73	White Ohio	Farmer Seed Co.	9-10 ripe	168	"	"	lt. russet	"	..	85	85	206.8	56	8	28	8
74	Thoroughbred	" " "	¼ ripe	171	"	long oval	rd. russet	med. deep	1	65	65	243.6	67	10	18	5
75	Abundance	" " "	¼ ripe	171	"	med.lg.& fl.	white	shallow	3	90	85	184.2	89	7	4	
76	Bliss Triumph	" " "	ripe	171	"	round	red	medium	..	75	60	144.1	89	8	2	1
77	Early Market	" " "	⅔ ripe	169	"	long oval	rd. russet	"	3	75	70	161.8	20	7	65	8
78	Lakeside Champion	" " "	nearly gr.	146	"	long	"	med. deep	5	80	80	133.1	78	16	1	5
79	Snow Flake	" " "	¼ ripe	148	"	oval	white	shallow	..	85	85	164.9	67	15	15	3

The percentage of large potatoes may be found by subtracting the percentage of small potatoes from 100.

*60 pounds in a bushel.

†The following varieties were published under other numbers in Bulletin No. 39 as follows: No. 39 as No. 262, No. 40 as No. 263, No. 41 as No. 264, No. 42 as No. 265, No. 43 as No. 266, No. 45 as No. 268, No. 46 as No. 269, No. 47 as No. 270, No. 48 as No. 271, No. 49 as No. 272, No. 50 as No. 273.

Each plot consisted of one row four hundred and twenty-eight feet long. Fifteen pounds of potatoes were planted in each row, which made one and two pieces in a hill.

The spring was favorable. The potatoes came up well and made a good stand in almost every case. They were well cultivated and kept free from weeds, but were not cultivated deep and received no hilling.

Digging was begun September 30th and completed October 20th. On the night of September 27th all of the potatoes which were exposed at the surface of the ground were frozen. At digging the frozen ones were sorted out and weighed and the percentage of frozen potatoes determined as given in Table XXIV. The difference in the percentage of frozen potatoes between the several varieties indicates which kinds develop the most tubers near the surface. The hills in each row were counted at digging time—one hundred and seventy-one hills in a row is a perfect stand. The number of hills of each variety dug is noted in the table, but the yields are calculated in every case for a full row. The accompanying table gives a very complete description and record of the results of the trial.

Sixteen varieties out of the forty kinds grown in 1899 were planted in the field trial in 1900. The potatoes were planted May 18th on fall plowed ground, which had been cultivated and was in good condition.

The potatoes came up evenly and were well cultivated and cared for during the season. All varieties were injured by the protracted drouth of June and July and all were more or less attacked by root rot, which entirely destroyed some of the hills. The early varieties were fully ripe and most of the vines were dead at frost September 16th. The vines of the later sorts were in every case partly mature.

The description of each of the varieties named in Table XXV has been given in the record of the 1899 crop and will not be repeated here. (See Table XXIV.)

TABLE XXV.—VARIETIES OF POTATOES, CROP OF 1990.

Record No.	Variety	Yield per Acre Bushels	Marketable Per ct	Small Per ct	Scab-by Per ct	Stage of Maturity of Vines at Frost Sept. 16
*39	Early Andes.........	103.2	73	19	8	Ripe.
*40	Early Dawn...	157.2	71	12	17	Ripe.
*43	Carman No. 1........	103.0	80	20	0	⅘ ripe.
*46	Burpee's Superior....	99.7	63	29	8	⅓ ripe.
*47	Rural N. Yorker No. 2.	79.6	76	24	0	½ ripe.
*48	Six Weeks	150.5	74	8	18	Ripe.
*49	Early Ohio...........	140.0	59	14	27	Ripe.
*50	World's Fair.........	44.5	69	26	5	Mostly ripe.
54	Pingree.............	82.6	61	36	3	Green.
55	Freeman	108.1	87	13	0	⅓ ripe.
56	Triumph.............	97.2	73	27	0	Ripe.
59	Ideal....	91.0	77	18	5	½ ripe.
67	Secretary Wilson....	86.0	72	22	6	Mostly ripe.
73	White Ohio..........	130.2	69	20	11	Ripe.
74	Thoroughbred	97.6	65	29	6	⅔ ripe.
75	Abundance...........	59.7	61	22	7	⅔ ripe.

*These varieties were published under other numbers in Bulletin No. 39, as follows: No. 39 as No. 262, No. 40 as No. 263, No. 43 as No. 266. No. 46 as No. 269, No. 47 as No. 270, No. 48 as No. 271, No, 49 as 272 and No. 50 as No. 273.

TABLE XXVI.—VARIETIES OF POTATOES GIVING HIGHEST YIELDS IN 1900.

Record No.	Variety	Yield per Acre Bushels	Harvest Season
40	Early Dawn................................	157.2	Early.
48	Six Weeks.................................	150.5	Early.
49	Early Ohio................................	140.0	Early.
73	White Ohio................................	130.2	Early.
55	Freeman...................................	108.1	Medium late
39	Early Andes...............................	103.2	Early.
43	Carman No. 1..............................	103.0	Medium late

TABLE XXVII.—GIVING VARIETIES OF POTATOES GIVING HIGHEST YIELDS AS AN AVERAGE FOR THREE CROPS, 1898, 1899 AND 1900.

Record No.	Variety	Yield per Acre Bushels	Harvest Season
40	Early Dawn	168.5	Early.
46	Burpee's Superior	163.0	Medium late.
39	Early Andes	161.6	Early.
48	Six Weeks	154.6	Early.
49	Early Ohio	148.3	Early.
43	Carman No. 1	136.4	Medium late.
47	Rural New Yorker No. 2	130.2	Medium late.

TABLE XXVIII.—VARIETIES OF POTATOES GIVING HIGHEST YIELDS, AVERAGE OF TWO CROPS, 1899 AND 1900.

Record No.	Variety	Yield per Acre Bushels	Harvest Season
40	Early Dawn	179.5	Early.
74	Thoroughbred	170.6	Medium.
73	White Ohio	168.5	Early.
46	Burpee's Superior	167.8	Medium late.
48	Six Weeks	166.6	Early.
49	Early Ohio	156.5	Early.
55	Freeman	154.8	Medium late.
67	Secretary Wilson	154.0	Medium early.
39	Early Andes	153.8	Early.
43	Carman No. 1	151.7	Medium late.

In this locality none except the early maturing varieties of potatoes can be depended upon for a crop each year. In other parts of the state the late sorts are successfully grown. Among the varieties tested at the station, World's Fair, Carman No. 1, Freeman and Rural New Yorker No. 2 may be mentioned as late kinds, which can be recommended for many good qualities. Other late varieties have outyielded these sorts, but are not so good in shape, size or quality.

Of early potatoes, the Early Ohio is still one of the best. The seed secured from Northrup, King & Co., produced a very good strain of this excellent potato. The Early Dawn and Early Andes are other good early varieties. These varieties are much like the Early Ohio. For the three year test, Early Dawn has been the largest yielder of any variety in the trial. The Early Beauty of Hebron is a good yielder, but not so good in shape and a little later than the Ohio and Andes.

THICKNESS OF PLANTING POTATOES.

This experiment was begun in 1898 and continued in 1899 but not in 1900. Early Ohio No. 49 was the variety used. The seed was cut from two to three eyes to the piece and planted by hand in furrows about four inches deep. The potatoes were planted May 20th and 22nd. One row 428 feet long constituted a plot. These potatoes received the same cultivation as the varieties. Table XXIX gives the results of the trial, also the average yield for 1898 and 1899.

The results for 1899 are more irregular, but upon the whole similar, to those obtained in 1898. There is a general decrease in yield as the distance between the hills is increased. Doubling the amount of seed planted in hill did not increase the yield but it increases the proportion of small and scabby potatoes.

Close planting not only gives the largest yields but the potatoes are more even in size and less rough and scabby than those planted far apart. This is true for early potatoes, but may not be true for late maturing varieties. The study of the root systems of potatoes has shown that the late sorts have a more extended root system than the early kind. Accordingly they need more root room and more soil to feed upon.

TABLE XXIX.—THICKNESS OF PLANTING POTATOES.

Plot No.	How planted	No. of pieces in a hill	No. of hills harvested	Yield per acre	Marketable	Small	Scabby	Frozen	Average yield per acre for two years—1898-1899
				bu	pr ct	pr ct	pr ct	pr ct	bu
1	3⅓ feet by 10 in....	1	420	226.1	83	5	7	5	216.6
2	3⅓ feet by 12 in....	1	389	218.5	83	7	5	5	200.1
3	3⅓ feet by 14 in....	1	347	219.7	83	6	6	5	193.2
4	3⅓ feet by 16 in....	1	308	190.0	54	8	29	9	175.4
5	3⅓ feet by 18 in....	1	253	117.5	84	5	9	2	137.2
6	3⅓ feet by 20 in....	1	253	147.1	83	7	4	6	140.6
7	3⅓ feet by 24 in....	1	197	206.3	76	7	9	8	161.8
8	3⅓ feet by 30 in....	1	160	189.5	76	9	9	6	155.4
9	3⅓ feet by 36 in....	1	141	161.6	57	13	24	6	128.2
10	3⅓ feet by 24 in....	2	181	157.4	51	10	29	10	134.3
11	3⅓ feet by 30 in....	2	179	180.9	60	13	19	8	145.7
12	3⅓ feet by 36 in....	2	114	193.2	53	11	26	10	95.3

DEPTH OF PLANTING POTATOES.

This experiment was discontinued in 1900. In 1899 Early Ohio potatoes were used in this trial and the seed was prepared as described in the thickness of seeding trial. The potatoes were planted by hand, one piece in a hill, in rows three and one-third feet apart. The hills were eighteen inches apart in the row. The planting was done May 22d. The soil was in much better condition than it was the year before. The potatoes all came up well, the deeper plantings giving a better stand than the shallow planted plots. In 1898 those planted more than six inches deep came up very poorly. Table XXX gives the results of the trial and also the average yields for two years.

DEPTH OF PLANTING POTATOES.

Plot No.	Depth planted	Stand	No. of hills harvested	Yield per Acre	Marketable	Small	Scabby	Frozen	Average yield for two yrs, 1898-1899
				bu	pr ct	pr ct	pr ct	pr ct	bu
1	3 inches......	good	266	197.1	67	10	13	10	152.6
2	4 inches......	good	255	199.2	76	9	9	6	159.5
3	5 inches......	good	272	191.1	82	12	5	1	140.4
4	6 inches......	good	256	188.0	78	10	8	4	148.2
5	7 inches......	good	288	185.7	88	9	2	1	139.5
6	8 inches......	good	280	180.3	87	8	5	0	134.6

The potatoes planted three to five inches deep gave the largest yields, but a poorer quality of tubers than those planted deeper. Those planted deep gave scarcely any loss from freezing and very little from scabbiness and were the nicest and best selling potatoes produced.

Experiments conducted at this station show that shallow, flat cultivation gives larger yields of potatoes than deep cultivation and hilling. In light soils, as proven by trials in other states, shallow, level cultivation gives the best results. It would seem better, therefore, to plant potatoes fairly deep, five to six inches at least, and give them surface cultivation rather than to plant shallow and be obliged to hill in order to keep the tubers beneath the ground. The root study, referred to in the discussion of thickness of planting, shows that deep cultivation and hilling must injure the roots of the plants. Hilling also opens up the ground and exposes more surface for evaporation, thus unduly drying out the soil.

ROOT CROPS.

Plot of Mammoth Yellow Giant Mangels planted June 8, 1899, in drills two and one-half feet apart yielded at the rate of eight tons six hundred twenty-six pounds per acre. The seed was old and germinated poorly. The poor stand accounts for the small yield. In 1898, thirteen and one-half tons of these beets were grown on an acre. In 1900 a large crop of mangels was harvested, but the weight of the crop was accidentally lost.

Two varieties of rutabagas were grown in 1899. The seed was planted with the grain drill, in rows two and one-half feet apart. Later the plants were thinned to six inches apart. The crop was well cultivated and weeded.

Hurst's Monarch Swede from Northrup, King & Co. yielded seven tons, eighteen hundred sixteen pounds per acre. White Russian from Farmer Seed Co. gave a yield of seven tons, fourteen hundred and eight pounds per acre. More than one-half of the roots in each case were small and of little value.

In 1899, a small plot of five-hundredths of an acre of sugar beets planted with the Planet, Jr. seed drill, in rows twenty inches apart and thinned four to six inches in the row yielded at the rate of thirty-two tons of beets per acre. Beets grown here are not rich enough in sugar to be of value for manufacturing purposes, but they make an excellent feed for sheep and cattle.

J. H. SHEPPERD,
A. M. TEN EYCK.

EXPERIMENTS WITH BEANS.

In 1898 two plots of common navy beans were planted on June 15th. Both were planted with a corn planter. On one plot the rows were forty-four inches apart or the full width of the planter; on the other the rows were twenty-two inches apart. Frost on the night of September 8th of that year found these beans still immature, although those planted closest were nearer ripe and produced some good beans.

In 1899 this trial was continued. Navy beans were planted in rows twenty-two, twenty-four and thirty-six inches apart. The first plot was planted with the corn planter. The beans were planted at about the same rate in the row, as described under varieties. The first plot named was not planted until June 12th, the others were planted June 8th. The following are the results obtained:

	Yield Per Acre
Beans drilled in rows two feet apart	15.7 bu
Beans drilled in rows three feet apart	12.2 bu
Beans planted with corn planter in rows twenty-two inches apart......	14.2 bu

The close planting in drills has given the best results. There was not much difference in the quality of the beans, but those planted in rows two feet apart ripened several days earlier than those planted three feet apart.

VARIETIES OF BEANS.

In 1899 six varieties of beans advertised by northwestern seedmen were secured and planted in our trial plots. Each plot consisted of one row four hundred and twenty-eight feet long. The beans were planted on June 8th, with the grain drill, in rows three feet apart, by stopping up part of the feed holes. Small beans like the navy may be planted very well in this way but the larger kinds in this trial were split more or less in being forced through the feed holes of the drill. About one quart of beans was planted in a row. At this rate it would take one bushel to plant an acre. For the Dewey Navy and California Wonder varieties, the drill was set to sow three and one-half bushels of oats per acre. This rate planted the beans fairly thick and gave a good stand. The feed was opened wider for the larger beans.

All the varieties came up well and made a good stand. They were well cultivated and kept free from weeds. Each of the six kinds tested ripened and made good crops, although there is considerable difference in the degree of earliness, as will be

noticed from Table XXII. The beans were pulled by hand and stacked in the field, in small round piles which were pinned down with sharpened sticks to keep them from being blown about by the wind. When dry the beans were hauled in and threshed (in this case with the flail.)

In 1900 the trial was made in practically the same manner as described, but the beans were planted in rows two feet apart, and each plot consisted of four rows of each variety. The ground used had been in rape in 1899, and was fall plowed. The beans were planted June 5th. The season was very unfavorable. After being stunted in growth by the drouth, the heavy rains of August caused a renewed growth, so that the beans, especially the earlier maturing sorts, failed to ripen evenly and many shrunken and blackened beans were the result. The wet fall was also unfavorable to the proper curing of the crop. The piles were protected by pinning a cap of foxtail over each, to shed the rain, otherwise the whole crop would have been lost. As it was when the beans were hand picked, only about one-half to two-thirds of the total yield was a salable product.

It is very essential that the beans be not allowed to get wet while piled in the field. Rain causes loss by blackening and shelling, so that just as soon as possible after pulling, the crop should be placed under cover. September in North Dakota usually furnishes favorable weather to cure beans. The yields and other data obtained in these trials are given in Table XXII.

TABLE XXII.—VARIETIES OF BEANS.

Bulletin No.	Variety	Where From	† Days Maturing	Height of Vines	Length of Pods	Beans			Yield per Acre		Average two Crops
						Color	Size	Form	1899	1900	
				In.	In.				*Bu.	*Bu.	*Bu.
1	Brown or Swedish..	Northrup-King Co......	95	12	3	Dark....	Med. large	Oval......	13.3	16.1	14.7
2	Aristook...........	" " "......	83	7	4	White....	Medium ..	kid'y shp'd	7.6	5.8	6.7
3	California Wonder.	" " "......	90	14	3	White....	Small.....	Oval......	13.3	8.4	10.8
4	Red Kidney........	" " "......	95	11	5	Light red	Large	kid'y shp'd	7.1	6.5	7.8
5	Dewey Navy	Oscar H. Will & Co......	85	11	3	White....	Smallest..	Oval	10.7	11.9	11.3
6	Great Northern....	" "......	82	7	4	White....	Medium ..	kid'y shp'd	9.0	6.4	7.2

* One bushel equals 60 lbs. † The description is for the crop of 1899.

The two seasons during which this trial of varieties has been carried on have been longer than the average. In 1899 the beans were planted June 8th and the first killing frost occurred September 12th. In 1900 the planting was completed June 5th and there was no killing frost until September 17th.

As an average for the two crops the Brown or Swedish bean stands first, Dewey Navy second, and California Wonder third in yielding qualities. Of these three, the navy bean is to be preferred on account of its early season and good selling qualities. The Great Northern and Aristook beans are a little earlier, but are very dwarf and light yielding varieties, and are not to be compared in selling value with the navy.

A. M. TEN EYCK.

THE EFFECT OF AGE AND LENGTH OF SPROUTS UPON THE VITALITY OF SEEDS.

WHEAT, ONE YEAR OLD.

A trial was made with one-year old wheat to determine whether it is fit for seed when it is that old. This wheat had been kept in small muslin bags in a dry room and was apparently healthy. The ordinary laboratory seed tester was used in this trial, one hundred kernels of each of twelve varieties of hard wheat were placed in separate folds or pockets of the germinator. The different varieties varied in the percentage of germination from seventy-three to one hundred per cent, the average germination being ninety and one-half per cent. Seven of the varieties showing the lower percentages of germination were given a second trial, this time in sand, but the results differed very little from those obtained in the first trial. The results indicate that most "one-year old" wheat which has been kept in a dry place is fit for seed.

A sample of experiment station No. 66 wheat of the crop of 1899, which had been bottled up in glass display bottles for about sixteen months gave ninety-eight per cent of germination and also showed a high degree of vitality. The germination was rapid, being completed the third day after the seed was placed in the germinator.

WHEAT, TWO YEARS OLD.

A single sample of goose wheat was secured for this trial. The sample had been kept in a bag in a dry room since it was threshed. One hundred kernels were tried of which ninety-seven germinated.

WHEAT, FIVE YEARS OLD.

A single sample of five-year old wheat was available. It was of the western or Pacific slope soft wheat grown in northern Idaho in 1895. It had been kept in a tin box and in glass display bottles in a warm room during that time. One hundred seeds were placed in the germinator, all of which grew. Other experiments in the United States and Canada have reported that soft wheat germinates more readily than hard wheat, which indicates that it is hardly fair to compare it with the hard wheats.

Two samples of wheat taken from sheaves saved from the crop of 1895 were used for this trial. One sample was a fife wheat, while the other was a blue stem variety. One of the samples gave one hundred per cent of sprouted kernels, while the other produced ninety-eight per cent of sprouted kernels. Professor E. S. Goff in the seventh annual report of the Wisconsin experiment station says "seeds, in general will retain their vitality longer in their natural covering, probably due to a more uniform degree of humidity." This fact may account for the good results which were secured in this trial.

SEVEN YEAR OLD MISCELLANEOUS SEEDS.

Buckwheat which had been kept in small muslin sacks since 1893 gave a germination of eighty-four per cent, which indicates that the vitality of the buckwheat is very good.

Mangel and clover seed did not germinate a single seed in two trials, one made in the germinator and one in a box of sand. Professor Lazenby of Ohio university, in Agricultural Science in 1895 says. "A vitality test of a series of seeds collected twelve years ago * * * of this series the seeds of clover, the common red and the white clover were the only ones that gave evidence of any vitality. Of the red clover twenty-six per cent germinated and of the white clover five per cent." Why the clover in our test did not germinate cannot be accounted for.

EIGHT YEAR OLD WHEAT.

This sample of wheat was gathered for display purposes and was used at the World's Fair in 1893. It has been kept in a glass case since that time for display and was shown in bundles. The vitality was very low in this sample, as is shown by the fact that only three per cent of it germinated. The seeds which sprouted, put out their germs upon the third and fourth days after being placed in the germinator.

In the seventh experiment station report of the United States copied from a German bulletin, which A. Bergerstein in a trial of testing seeds from one to ten years old the following is quoted: "Part of the specimens were taken from sheaves of grain and others as they came from the threshing machine. They were placed in paper pockets and kept in the laboratory. They were

tested at temperatures varying from nineteen to twenty-six degrees F. At the end of ten years, winter wheat germinated seventy-five per cent, rye two per cent, summer barley ninety-five per cent and oats ninety-three per cent. The following tabular statement shows the results:

SHOWING VITALITY AND VARIATION OF OLD SEED.

Variety of Wheat	No. of Test	Age of Seed	Date Started	Kernels Germinated				No. Tested
				3rd Day	4th Day	5th Day	Per Cent	
Minn. No. 51................. Station No. 203...............	1	1899	Oct. 29	96	1	..	97	100
Station No. 214...............	2	1899	29	86	4	2	92	100
Minn. No. 177................ Station No. 215...............	3	1899	29	70	18	5	93	100
Station No. 151...............	4	1899	29	61	14	5	80	100
Station No. 216...............	5	1899	29	68	12	9	89	100
Station No. 146...............	6	1899	29	45	18	14	77	100
Station No. 197...............	7	1899	29	98	1	..	99	100
Station No. 256...............	8	1899	29	94	3	1	98	100
Minn. No. 163................ Station No. 212...............	9	1899	29	53	10	10	73	100
Station No. 235...............	10	1899	29	69	16	3	88	100
Station No. 264...............	11	1899	29	97	1	1	99	100
Station No. 202...............	12	1899	29	99	1	..	100	100
Goose Wheat.................. Station No. 182...............	13	1898	29	90	7	..	97	100
Buckwheat No. 3............. New Japanese...............	15	1893	29	77	7	2	86	100
Mangel	16	1893	29	..	..	..	....	100
Clover	17	1893	Nov. 21	..	..	..	....	100
World's Fair Wheat..........	14	1892	Dec. 13	1	2	..	3	100

A TRIAL WITH SPROUTED WHEAT.

To obtain fair samples of this year's wheat a small cupfull of the grain was dipped from the wheat as it came from the threshing machine. The kernels in the measure were counted, after which the sprouted seeds were separated from the sound ones and counted and the per cent of sprouted wheat calculated. One hundred kernels of the sound and one hundred kernels of the sprouted wheat were placed in the germinator. Sample No. 1 contained seven and one-half per cent of the sprouted wheat and ninety-seven and one-half per cent of the original mixed sample grew. Sample No. 2 containing thirty-one per cent of sprouted wheat gave ninety-two per cent of germination.

Sample No. 3, which contained forty-one and one-half per cent of sprouted kernels gave ninety-two per cent of germination.

Four samples of wheat were taken from bins as they had come from the threshing machine in the fall, and were placed in the germinator. They had been standing out in most of the rain during the fall, and some of the bundles had been reshocked. A very small per cent of it was sprouted.

Sample No. 4 contained thirteen and one-tenth per cent of sprouted kernels and in the original wheat ninety-seven per cent of the sound kernels, and eighty-seven per cent of the sprouted kernels germinated, making a total of ninety-four and seven-tenths per cent germination for the original sample of wheat.

Sample No. 5 contained twelve and one-tenth per cent of sprouted kernels in the original wheat; ninety-nine per cent of the sound, and eighty-six per cent of the sprouted wheat germinated, making a total of ninety-eight and three-tenths per cent of the original machine sample of wheat germinated.

Sample No. 6 contained six and six-tenths per cent of sprouted kernels, ninety-six per cent of the sound kernels and sixty-eight per cent of the sprouted one germinated, making a total germination of ninety-three per cent of the original, or machine sample of sprouted wheat.

Sample No. 7 contained seven and nine-tenths per cent of sprouted kernels; ninety-nine per cent of the sound kernels germinated and seventy-three per-cent of the sprouted kernels germinated, making a total of ninety-six and eight-tenths per cent of the original wheat germinated.

The length of the sprouts which the bin sample had reached could not be determined, as the threshing and general handling had broken them off.

In this trial the number of sprouted kernels in the seed ranged from six to thirteen, and the four samples averaged ten. The average percentage which sprouted was ninety-seven and seven-

tenths. Sprouted seed is always weakened and therefore poorer than sound seed would be, but the above results indicate that a good crop could be secured with it, and seeding five per cent heavier would give the normal number of plants per acre. The following table gives the results:

VARIATION IN GERMINATION AND VITALITY IN THE 1900 CROP OF WHEAT.

Variety of Wheat	No. of Test	Age of Seed	Date Started	Kernels Germinated						Per Cent	No. Tested
				2nd Day	3rd Day	4th Day	5th Day	6th Day	7th Day		
Minn. 163... .... Station No. 225...	1	1900	Nov. 5	87	13	.	..	..	..	100	100
Station No. 223...	1	1900	5	..	..	69	..	..	..	69	100
Screenings.......	2	1900	5	96	2	..	..	..	..	98	100
Screenings.......	2	1900	5	..	..	81	..	..	..	81	100
Tailings.........	3	1900	5	95	5	..	..	..	..	100	100
Tailings.........	3	1900	5	..	..	80	..	..	..	80	100
Haynes' Blue St'm No. 15, sound...	4	1900	Dec. 6	77	15	2	1	1	1	97	100
Haynes' Blue St'm No. 15, sprouted.	4	1900	6	58	20	5	..	..	..	83	100
Haynes' Blue St'm No. 14, sound...	5	1900	7	85	12	2	..	..	..	99	100
Haynes' Blue St'm No. 14, sprouted.	5	1900	7	14	9	3	..	..	..	86	100
Minn. No. 163, sound..........	6	1900	8	96	2	1	..	..	..	96	100
Minn. No. 163, sprouted.......	6	1900	8	62	6	..	..	..	..	68	100
Minn. No. 163, sound..........	7	1900	8	95	4	..	..	..	..	99	100
Minn, No. 163, sprouted.......	7	1900	8	66	6	1	..	..	..	73	100

A trial was made to determine what length of sprouts wheat may have and regerminate. Wheat of the Minnesota No. 163 variety from which the sprouted kernels were carefully removed by hand picking, was used in this trial. Two hundred kernels were placed in each of eight pockets in the germinator, and as soon as sprouts were visible on the kernels in the first pocket, they were taken out and thoroughly dried. The next day the seeds were taken from the second pocket, the day following the seeds from the third pocket were taken out and dried, and so on until the pockets were emptied. This plan make the last sprouts seven days older than the first ones. The radicles (root sprouts) and plumules (stem sprouts) were measured upon the different dates when the seeds were placed in the germinator for the second trial. After being dried for eight and one-half days they were again placed in the germinator to see what per cent of them would grow. The following table shows the variation in the period of growth, and what per cent germinated:

VITALITY OF SPROUTED WHEAT AND VARIATION IN ITS MEAN PERIOD OF GERMINATION.

Variety of Wheat	No. of Test	Age of Seed	Date Started	Kernels Germinated						Per Cent	No. Tested	Length In.	
				2nd Day	3rd Day	4th Day	5th Day	6th Day	7th Day			Plumule	Radicle
Minn. No. 163, Stat'n No. 212.	1	1900	Nov. 21	39	20	8	8	..	..	75	100	5-16	¾
Minn. No. 163, Stat'n No. 212.	2	1900	22	31	18	21	5	..	..	75	100	¾	1¼
Minn. No. 163, Stat'n No. 212.	3	1900	23	10	36	7	1	..	..	54	100	2	2½
Minn. No. 163, Stat'n No. 212.	4	1900	20	53	12	10	3	2	1	81	100	⅛	½
Minn. No. 163, Stat'n No. 212,	5	1900	19	67	17	3	3	1	..	91	100	Just Sprouted.	
Minn. No. 163, Stat'n No. 212.	6	1900	24	41	13	4	3	..	..	61	100	2¾	3½
Minn. No. 163, Stat'n No. 212.	7	1900	25	33	8	16	1	..	..	58	100	3½	4½
Minn. No. 163, Stat'n No. 212.	8	1900	26	20	25	..	..	..	..	45	100	3½	5

The second sprouting in pockets numbers 5 and 4, with sprouts one and two days old gave ninety-one and eighty-one per cent respectively. The sprouts on these seeds were healthy, but the sprouts on the kernels in the pockets containing the older sprouts were weak and sickly. The sprouts (stems) upon sample No. 4 were one-eighth inch long, when the sample was placed in the germinator the second time. It was readily noticed that the sickliness and weakness of growth increased with the age and consequent length of sprout. The oldest sprouts (stems) reached a length of three and one-half inches. The weights of the one hundred kernels constituting the samples in each of the pockets were taken after the first germination. The weights decreased gradually with the increase in age and consequent lengthening of the stem. The sprouts were broken off and not included in the weights recorded.

This trial indicates that sprouted wheat will regerminate and form healthy sprouts until the stem (plumule) has reached a length of three-fourths of an inch in the first germination and an average of eighty per cent of all sprouted wheat with the length of the stem not exceeding one-half an inch will again germinate.

STOCK AND BIN BURNED WHEAT.

In bulletin No. 9 of this station Professor Bolley writes: "Any seeds which have at any time been heated because of moisture when in bulk, are very liable to have been injured beyond ability to grow."

A trial made by the writers with one hundred and fifty kernels of stack burned wheat gave sixty-four and seven-tenths per cent of germination. This wheat could not have been burned very much, or the germ in the seed would have been killed, but nevertheless it would not be safe to use it for seed.

A trial was also made with a sample of bin burned wheat. Five hundred kernels were placed in the germinator. The sprouts were healthy but showed a somewhat longer period of germination, and gave an average germination of sixty-two and four-tenths per cent. This would not be safe to use for seed. Neither the stack burned nor the bin burned wheat could have burned very much, judging from the large germination that took place.

FROZEN WHEAT.

Superintendent S. A. Bedford of Manitoba in his report for 1890 writes: "Although the loss upon slightly frozen grain was small, the No. 3 or badly frozen wheat gave considerably less (yield) than No. 1 hard wheat and in unfavorable seasons no doubt would be greater.

No. 1 hard wheat sowed on breaking yielded thirty-three bushels per acre, while No. 3, badly frozen yielded twenty-nine bushels. On fallow No. 1 hard yielded twenty-four and one-half, and No. 1 frozen yielded twenty-three and one-half bushels per acre."

Professor Greene of the Minnesota station in bulletin No. 6 reports that results from six trials show a range of germination of from fifty-two to eighty-five per cent and in most cases produced vigorous, thrifty sprouts. Samples weighing forty pounds per bushel and less showed low germinating powers.

A trial of frosted grain by Professor Keffer of the South Dakota station is reported to have given precentages of germination ranging from fifty-four to eighty-two.

The above reports would certainly indicate that frosted and frozen wheat may be fit for seed and that a germination trial is the only sure way to determine its value.

CORN ONE YEAR OLD.

A variety known as Pre-historic corn which has been bottled up since the spring of 1899 germinated very slowly when placed in the germinator, requiring eight days for completion of the process. The same seed showed ordinary vitality nearly two years before when it was planted on the station ground. Only sixty-three per cent of it grew, which shows that it was not fit for seed.

Corn samples No. 14, 15 and 16 had been kept in small muslin sacks, in a dry room since 1899. They contained a few shrunken kernels, as if the corn had been husked somewhat green.

These varieties of corn were also slow in starting to germinate, requiring four days to complete its germination, the three varieties germinated ninety, ninety and eighty-four per cent respectively, or an average of eighty-eight per cent.

The sprouts on this corn were healthy, and it undoubtedly would be fit for seed if an allowance of ten per cent was made for the lack of vitality in some of the kernels. The lack of vitality may have been due in part to the corn not having been fully matured.

CORN SIX YEARS OLD.

A sample of Minnesota King corn from the crop of 1894 was given a germination trial. The corn remained upon the cob until shelled for use in this experiment. The mean period of germination was as high as that for the 1899 corn, requiring seven days to complete its germination, at the end of which time, seventy-seven per cent of it had sprouted.

VITALITY AND VARIATION IN THE TIME OF GERMINATION OF CORN.

Variety of Corn	No. of Test	Age of Seed	Date Started	Kernels Germinated					Per Cent	No. Tested
				3rd Day	4th Day	5th Day	6th Day	7th Day		
Minnesota King..........	1	1900	Nov. 29	15	76	7	..	..	98	100
Minnesota King..........	2	1900	29	2	47	39	9	1	98	100
Pre-historic Corn.........	3	1899	29	11	26	19	2	5	63	100
Station No. 589............	4	1899	Oct. 29	27	15	35	13	..	90	100
Station No. 190............	5	1899	29	60	4	25	1	..	90	100
Station No. 555...........	6	1899	29	25	20	22	17	..	84	100
Minnesota King..........	7	1894	Nov. 29	3	25	23	16	10	77	100

ONE YEAR OLD OATS.

Three samples of our 1899 crop of oats was placed in the germinator to see what per cent of it would grow and if it would be safe to use oats of that age for seed. These samples had been kept in small muslin bags in a dry room, and consequently in the best possible condition. The vitality was good. Samples No. 1, 2 and 3 germinating one hundred, ninety-six and ninety-nine per cent respectively. Sample No. 1 completed its germination the third day, No. 2 in five days, and No. 3 four days after being placed in the germinator.

This trial indicates that old oats, i. e. which has been carried over one season under good condition is comparatively safe to use for seed.

EIGHT YEAR OLD OATS.

Samples No. 4 and 5 are from the crop of 1892 and were collected for exhibition at the World's Fair in 1893. They have been kept in exhibition cases in the bundle or sheaf since that time.

Number 5 is a variety of wild oats and was used with the cultivated varieties to compare its vitality. It has been standing in its natural covering in the straw since then, and undoubtedly this has helped it to retain its vitality. The germination for the two samples were eighty-seven and seventy-three per cent respectively.

ONE YEAR OLD BARLEY AND SPELT.

Two samples of barley from our 1899 crop were tested. They had been placed in small muslin bags and kept in a dry room. By reference to the table it will be noticed that the vitality of No. 2 was not as good as that of No. 1. The writers can find no cause for this unless it was due to the maturity of the barley, the one sample appearing to have been slightly more mature than the other. The germination of the two samples gave ninety-eight and eighty-eight per cent respectively.

The spelt was kept in the same condition as the barley and germinated ninety-eight per cent. In all three samples it will be noticed, the mean period of germination was very short, only one seed germinating after the third day.

VITALITY AND VARIATION IN GERMINATION OF OATS.

Variety of Oats	No. of Test	Age of Seed	Date Started	Kernels Germinated 2nd Day	3rd Day	4th Day	5th Day	6th Day	7th Day	Per Cent	No. Tested
Oats	1	1899	Nov. 30	63	37	..	..	..	..	100	100
Lincoln (62)	2	1899	Dec. 1	76	16	1	2	1	..	96	100
Station No. 46	3	1899	1	89	9	1	..	..	..	99	100
Oats	4	1892	Nov. 21	..	59	24	2	2	..	87	100
Wild Oats	5	1892	21	..	7	39	9	3	15	73	100

VITALITY AND VARIATION IN GERMINATION OF BARLEY AND SPELT

Variety of Seed	No. of Test	Age of Seed	Date Started	Kernels Germinated 2nd Day	3rd Day	4th Day	Per Cent	No. Tested
Barley	1	1899	Nov. 30	57	42	..	99	100
Barley, Station No. 30	2	1899	Dec. 1	76	12	..	88	100
Spelt	3	1899	Nov. 30	58	39	1	98	100

FLAX FROM THE CROP OF 1900.

The samples of flax which have been available this year have been injured more or less by rain during the fall, which has made a large percentage of black and shriveled kernels. The seeds were counted and separated as described for wheat, and the per cent of shriveled and black kernels counted. One hundred kernels of each kind were placed in the germinator.

VITALITY AND VARIATION IN GERMINATION OF FLAX.

Variety of Flax	No. of Test	Age of Seed	Date Started	Kernels Germinated						Per Cent	No. Tested
				2nd Day	3rd Day	4th Day	5th Day	6th Day	7th Day		
Flax, sound...........	1	1900	Nov. 6	..	96	..	..	..	..	96	100
Flax, shriveled.......	1	1900	6	..	74	..	..	..	..	74	100
Flax, sound..........	2	1900	6	..	87	..	..	..	..	87	100
Flax, shriveled.......	2	1900	6	..	49	..	..	..	..	49	100
Flax, sound	3	1900	10	93	2	..	..	..	..	95	100
Flax, shriveled.......	3	1900	10	81	6	..	..	..	..	87	100
Flax, sound...........	4	1900	10	53	8	2	.	..	..	63	100
Flax, shriveled.......	4	1900	10	19	7	..	..	..	..	26	100
Flax, ice	5	1900	10	..	31	14	2	1	1	49	100
Flax, sound..........	6	1900	Dec. 13	8	8	1	1	..	..	9	200
Flax, shriveled.......	6	1900	13	1	..	..	..	..	..	½	200
Flax, sound...........	7	1899	Nov. 19	94	2	..	..	..	..	96	100
Flax, sound...........	8	1899	30	48	14	6	1	..	.	69	100
Flax, sound (2nd trial)	8	1899	Dec. 14	50	12	6	2	..	..	70	100

From the tabular statement it will be seen that flax sample No. 1 originally contained nineteen and seven-tenths per cent

of black kernels, that ninety-six per cent of the sound and seventy-four per cent of the black and shriveled seeds germinated, making a total of ninety-four per cent of the original flax seed which had germinated.

Sample No. 2 contained twenty-five and one-tenth per cent of black and shriveled seeds, eighty-seven per cent of the sound and forty-nine per cent of the black and shriveled kernels germinated, making a total of seventy-four per cent of germination in the original sample.

Sample No. 3 had forty and six-tenths per cent of black and shriveled kernels. In this sample ninety-five per cent of the sound and eighty-seven per cent of the black kernels germinated, making a total of ninety-four per cent of the original flax that germinated.

Sample No. 4 contained forty-seven and two tenths per cent of black and shriveled kernels. In this sample sixty-three per cent of the sound and twenty-six per cent of the black kernels germinated, making a total of the original flax that germinated forty-two per cent.

Sample No. 5 had been lying out in the rain and snow until November 17th. It had been frozen and contained as large a bulk of ice as of seed, when it came from the separator on the date named. The sample was dried and found to contain twenty-seven and four-tenths per cent of water. Of this sample of flax forty-nine per cent germinated.

Sample No. 6 was flax that had been lying out in the rain. It had been threshed while wet and placed in a bin where it had heated. Of this sample seventy-three and eight-tenths per cent was black and shriveled. Two hundred kernels of the sound seed and an equal number of the black and shriveled ones were placed in the germinator, only nine per cent of the sound and one-half per cent of the black kernels germinated, or a total of only two and seven-tenths per cent of the original flax seed. This low vitality is attributed to the bin burning.

ONE YEAR OLD FLAX.

Sample No. 7 was of the 1899 crop. It was all bright flax and germinated very quickly. The vitality was also very strong as ninety-six per cent of it germinated.

Sample No. 8 was also from the 1899 crop but neither the vitality nor the mean period of germination was as good as for No. 7, as only sixty-nine per cent of it germinated. This flax was again tried in the germinator and gave seventy per cent of germination or an average of sixty-nine and one-half per cent for the two trials. The sample of flax was examined very closely, but we could find no reason why it would not grow.

It seems to the writers that the only safe method of determining what amount of any particular sample of seed will grow is to try it in a seed germinator, where the time required to sprout and the strength and vigor of the growth of the seed can be seen. Mere sprouting if the growth is weak does not mean that a strong plant will result. It must be a matter of judgment and the person making the trial can get the best basis for judging by trying a sample of grain which is known to be good seed.

A good seed germinator can be made as follows: Invert a pie plate in an ordinary dinner plate and place a small amount of water in the dinner plate; place a cotton flannel cloth, wide enough to fold double from side to side over the inverted plate and long enough that the ends of the cloth will reach into the water in the largest plate. The cloth will carry the water up after the manner of a lamp wick, and seeds placed between the folds of the cloth will be kept moist enough to sprout. By lifting the upper fold of the cloth the seed can be examined at any time without doing them any harm. A second dinner plate of the same size as the first or larger one, should be placed over it, the rim resting upon the rim of the lower one. This upper plate simply prevents the rapid evaporation of the water. The above plan was illustrated by A. J. Pieters, in the United States Department of Agricluture Year Book of 1895.

J. H. SHEPPERD,
E. G. SCHOLLANDER.

ACKNOWLEDGMENTS.

During the past season A. M. Ten Eyck, M. S., has assisted me in conducting the experiment work undertaken by this department. The greater portion of the work has been carried jointly, while he has taken the entire responsibility for some pieces of work as will be seen by this report and by other publications.

Mr. H. M. Ash has acted as farm foreman during the past season and has aided the writer by becoming responsible for much of the detail work falling upon the department.

Mr. E. G. Schollander, an agricultural student in the college has given this department creditable assistance during the past six months.

This report contains a description of the results obtained by trial in which he became largely responsible for the details of the work.

J. H. SHEPPERD.

HORTICULTURAL DEPARTMENT.

To J. H. Worst, Director:

The work in this department has been modified somewhat during the past year, chiefly as regards fertilizer tests and work with vegetables.

The report for 1899 gives a brief outline and summary of the field work with different fertilizers upon the various garden vegetables and the last bi-ennial report gives the results of the experiments made under glass along the same lines.

The work under glass is being continued at the present time with celery, cabbage and tomatoes. The objects to be attained in these experiments are first to determine the exact proportion of each fertilizer required to give the maximum growth, and second to determine the kind of fertilizer best adapted to the different plants under trial. The fertilizers used are of five different kinds, all animal manures.

The field work with garden crops for the past season was along somewhat general lines, the object being to make the work illustrative and educational rather than distinctly experimental. This plan was adopted partly on account of the arrangements that had been made to bring a number of large farmers' excursions to the station, and also to lessen the expense of weighing and testing necessary when purely experimental lines of work are followed out.

The cultivation of vegetables in North Dakota in average years is attended with such little difficulty that there is no present demand for very elaborate or extensive experiments along that line. To develop new varieties of plants not fully successful in the state like the sweet corn, tomato and melons has been a part of the work of the department.

The line of work that does require experimentation is that of tree and fruit culture. Most of the inquiries coming to the department are from persons wishing to start a grove and set out a few bushes and small fruits about the garden. With the settlement of the newer portions of the state by those coming, for the most part, from regions where trees and fruits are common the first inquiry is as to what steps to take to give the new home some of the adornments and comforts of the old. Information

on these subjects must be furnished largely from our own experience and so far as possible the department is devoting itself to the cultivation of such trees, shrubs, fruits and general ornamental plants as are likely to succeed in the state.

With the limited funds at our disposal it has not been possible to carry on the cultivation of these to such an extent as the demands upon the department would otherwise warrant.

Aside from the original cost of stock, the labor of caring for a plantation of fifteen or twenty acres of trees has been quite out of the question. Such a feature properly managed could not fail to be a very valuable one, as it would afford opportunity to try the promising species of this and other countries and to determine what combination of species would give the best results after a given number of years. Enough money is wasted every year in nearly every county of the state by injudicious planting and improper management to more than maintain an arboretum ample for the needs of the institution. One correspondent writes that in his region alone over two hundred miles of hedge costing over $35,000 had been sold to the farmers and after all that great expense it was the general opinion among them that the hedge would prove a failure. Whether it succeeds or not the price is much too great to pay for a single experiment.

During the past season several additional varieties of plums and small fruits have been added to the station gardens and the leading varieties are now fairly well represented. With the constantly increasing sales of nursery stuff in the state by firms and salesmen not familiar with our local conditions, it will be well to make tests of nearly everything likely to be offered for sale as a possible protection to patrons, whether the articles promise much value to the discriminating buyer or not.

In those parts of the state where active measures had been taken in 1899 for the suppression of the Rocky Mountain locust, it did not appear in any numbers in 1900, but in the region of Willow City, where no previous work has been done there was a hatching out of this pest in numbers that might have caused alarm in ordinary years. The practical destruction of the grain crop by drouth in early summer and the continued rains during the balance of the season were discouragements quite too great for anything like a normal increase of this pest. It remains to be seen just how numerous they will be next season.

The two most conspicuous insect pests of the season were the canker worm that defoliated so many trees in the early summer and the box elder bug that appeared in such numbers in the fall. Inquiries concerning both of these pests were very numerous. The canker worm feeds upon almost any kind of tree foliage, generally avoiding the willows and poplars when other food is to be had and on the other hand showing a special fondness for

the box elders. The destruction is wrought by the larva of a moth. The female lays her eggs upon the tree in the fall or early spring and these hatch out into small green "measuring worms" that eventually grow to about an inch in length. As the females are wingless they may be prevented from ascending the trees by some mechanical contrivance, such as bands of wool or tin collars sloping downward. These applied in early fall will prevent ravages the following season. If this precaution has not been taken, the proper remedy is to spray the trees with a solution of paris green, at the rate of one pound to 150 gallons of water. This should be done as soon as the worms are discovered and repeated once or twice at intervals of a few days. If the operation is delayed till the worms are fully grown but little good will result. Unless some disease or other restricting influence appears, great damage may be expected from this pest next season.

The box elder bug feeds by sucking the juice of the trees, so the evidences of its ravages are not so alarming as those of the canker worm. Moreover it appears much later in the season when the possibilities of injury are not so great. It appears first as a small pale reddish bug without wings, but as the season advances and it passes through the different stages it takes on dark wings banded with red. It is then something over half an inch long and about half as wide at the base of the wings from whence it tapers gradually toward the rear. Late in the fall it congregates in masses upon the body of the trees or upon buildings where it may be killed by hot water. Since it feeds by sucking it cannot be poisoned, but it may be destroyed by spraying the trees with one part kerosene mixed with sixteen parts of strong soap suds.

Aside from the additional equipment of an arboretum already mentioned, the department should be supplied with more space under glass for starting or forcing plants and also with grafting and storage cellars where manual operations may be carried on by classes in the winter time, and where half hardy ornamental plants may be stored during cold weather.

Respectfully submitted,

C. B. WALDRON.

STATEMENT.

GOVERNMENT AGRICULTURAL EXPERIMENT STATION, NORTH DAKOTA.

FEDERAL APPROPRIATION.

Statement of receipts and expenditures from July 1, 1899 to July 1, 1900.

RECEIPTS.

Received from U. S. Hatch act, March 2, 1887 $ 15,000.00

DISBURSEMENTS.

Salaries	$ 6,218.14
Labor	5,232.12
Publications	969.20
Postage and stationery	110.11
Freight and express	33.24
Heat, light and water	299.55
Chemical supplies	74.83
Seeds, plants and sundry supplies	287.97
Feeding stuffs	237.60
Tools, implements and machinery	328.59
Scientific apparatus	91.85
Live stock	100.40
Traveling expenses	155.40
Contingent expenses	76.00
Building and repairs	750.00
Fertilizers	35.00
	$ 15,000.00

R. A. SHATTUCK,
Secretary.

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TYPICAL PLUM TREE, FIVE YEARS OLD, IN BUD (Station Grounds).

GOOD TYPE OF APPLE TREE, 5 YEARS FROM GRAFT, TRANSPLANTED AT 2 YEARS (Station Grounds).

SHELTER HEDGE OF GOLDEN RUSSIAN WILLOW, FIVE YEARS OLD (Station Grounds).

SHELTER BELT OF NORWAY SPRUCE (Station Grounds).

HEDGES OF GOLDEN RUSSIAN WILLOW, THREE YEARS OLD, TRIMMED LOW FOR ORNAMENTAL PURPOSES.

FOUR-YEAR-OLD TREE OF CAROLINA POPLAR. RETAINS ITS FOLIAGE LONG AFTER ADJOINING COTTONWOOD TREES ARE BARE (Station Grounds).

HEDGES OF GOLDEN RUSSIAN WILLOW, CARAGANA, AND BUFFALO BERRY—NAMED FROM RIGHT TO LEFT (Station Grounds).

HEDGE OF SOFT MAPLE WITH WIND-BREAK OF SAME SPECIES TO THE RIGHT.

TWELFTH ANNUAL REPORT

OF THE

NORTH DAKOTA

Agricultural Experiment Station

AGRICULTURAL COLLEGE, N. D.,

TO THE

GOVERNOR OF NORTH DAKOTA

February 1, 1902.

BISMARCK TRIBUNE
STATE PRINTERS AND BINDERS
1902

STATION STAFF.

J. H. Worst, LL. D.	Director
E. F. Ladd, B. S.	Chemist
C. B. Waldron, B. S.	Horticulturist
H. L. Bolley, M. S.	Botanist
J. H. Shepperd, M. S. A.	Agriculturist
A. M. Ten Eyck, M. S.	Assistant Agriculturist
T. R. Manns, B. S.	Assistant Botanist
L. B. Green, B. S.	Assistant Chemist
R. S. Northrop, B. S.	Assistant Horticulturist
H. M. Ash	Foreman in Agricultural Department
C. A. Baldwin	Foreman in Horticultural Department
Herman Croft	Herdsman
J. Jessen	Assistant Herdsman
C. E. Nugent	Secretary

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LETTER OF TRANSMITTAL.

Agricultural College, N. D., February 1, 1902.

To His Excellency, Frank White, Governor of the State of North Dakota :

Sir: As required by act of congress approved March 2nd, 1887, and section 945, Revised Codes of 1899, I hereby submit the twelfth annual report of the North Dakota Experiment Station, for the year ending February 1st, 1902, together with a financial statement of receipts and disbursements as required by law, for the government fiscal year ending June 30th, 1901.

Very respectfully yours,

W. H. ROBINSON,
President Board of Trustees.

REPORT.

To the Board of Trustees of the North Dokota Agricultural College and Experiment Station:

Gentlemen: I have the honor to submit to you the Twelfth Annual Report of the North Dakota Agricultural College and Experiment Station. The past season has been satisfactory for doing experimental work, but on account of insufficient drainage and excessive rainfall during the early part of July, a portion of the experimental farm was flooded with water, which resulted in considerable damage.

The experiments in agriculture were confined largely to crop rotation, conservation of moisture, seed breeding and seed selection, cultivation methods, etc. The experiments in horticulture were devoted to the growing of small fruits, berries, vegetables, planting trees, hedges, etc.

The following bulletins were published during the year:

No. 47 Humus and soil nitrogen.
Climatic studies with wheat, oats and corn.
Brome and timothy compared.
Austrian Brome hay.

No. 48. Wheat farming experiments and soil moisture studies.
- (1) The wheat crop of 1900 grown under different methods of farming.
- (2) A study of the conservation of soil moisture:
  - (a) By cultivation.
  - (b) By crop rotation.
  - (c) By different methods of summer fallowing.
  - (d) By manuring.
- (3) A study of the effect of the winter season upon the moisture content of the soil.
- (4) Weather and crop records for 1898, 1899 and 1900.

No. 49. Some points on fruit culture.

No. 50. Flax wilt and some minor problems affecting flax growing.

During the past year two frame barns were built in place of the combination horse and cow barn that was burned January 4, 1901. The new horse barn is a two-story structure and contains 18,180 feet of floor space. It contains a class room with seating capacity for one hundred twenty-five students, and is used for classes in stock judging, stock scoring, veterinary clinics, etc. The barn is built of the best material, and is very

attractive in appearance, and convenient in its general arrangements.

The cow barn is also frame, two stories, attractive in design and convenient in all its arrangements, with 14,330 feet floor space, and has connected with it a two hundred ton brick silo.

A very complete sewerage system has been constructed, connecting all the station buildings with the Ninth avenue trunk sewer, (city), which will enable us to materially improve the barn yards and adjacent grounds. The two barns were built at an expense of $17,900, and the sewerage system cost $5,300.

Since my last report farmers institutes were held at Buxton, Finley, Grafton, Valley City, Wahpeton, Crystal, Thompson, Drayton, Oakes, Cogswell, Edgeley, Lisbon, Kenmare, Minot, Fessenden, St. Thomas, Langdon, Park River, Larimore, Michigan City, Rugby, Bottineau and Cando. At eleven of these institutes, members of the station staff took complete or partial charge of the lecture work, and the regular institute corps, consisting of T. A. Hoverstad, of the Minnesota sub-Experiment Station at Crookston, Hon. L. A. Ueland of Edgeley, and E. G. Schollander, conducted the others.

Col. Wilkinson, of the Great Northern Railway Company, rendered valuable assistance in the northern counties.

The demand for farmers institutes more than keeps pace with the funds appropriated for that purpose. At least $5,000 per year should be made available by the legislative assembly for farmers institutes, and at least one farmers club or agricultural society should be organized in each county with assurance of an institute conducted at state expense, once a year. Many farmers of every community are well qualified to take a leading part in the discussions incident to a farmers institute, and where a permanent organization is maintained, as above indicated, several institutes of a local character can be held annually without material expense to the organization, and with much profit to the farming community.

A very marked improvement in agricultural methods, crop rotation, diversified farming, seed selection, is already observable throughout the state, and much of this improvement came so unconsciously that the farmers themselves have scarcely realized the extent of the progress they have made, or the cause. Many problems of great importance to our agricultural interests yet await solution, not the least of which is the movement of moisture in the soil.

The reports made to me by the heads of the different departments are of unusual interest, and convey much valuable information for the farmers of the state, all of which I respectfully submit.

J. H. WORST,
Director.

CHEMICAL DEPARTMENT.

To J. H. Worst, Director:

Sir: The present is the twelfth annual report submitted by the writer for the chemical department, and covers briefly the chemical work done in the Experiment Station for the year 1901.

There has been a large increase, during the past year, in both analytical and investigational work required of the chemical department. This work represents demands pretty generally from all parts of the state. The amount of correspondence has nearly if not quite doubled during the past year. Frequently, the questions asked have called for a considerable amount of time in compiling data, or work in making experiments that would enable us to intelligently reply to the questions.

During the past year two lines of co-operative work have been carried on in connection with the department of agriculture at Washington. One of these lines of investigation is for the purpose of determining the amount of water necessary to produce a given amount of plant growth in relation to the available plant food present in the soil. It is expected this investigation will be continued for another year. Co-operative work in sugar beet experiments with the farmers of the state was also undertaken by this department; and seed furnished to nearly 1,600 farmers in the state. This necessitated the making of several hundred analyses of beets during the past fall, the results of which will be published as a bulletin at a later date.

SUMMARIES OF TEMPERATURE, RAINFALL AND SUNSHINE.

The record for previous years will be found in preceding reports, and below we give the maxima, minima, and mean monthly temperatures for the year 1901:

TEMPERATURES AND RAINFALL, 1901.

Months	Means	Maximas	Minimas	Rainfall inches
January	6.4	24	—20	.05
February	6.2	44	—21	.11
March	8.2	51	—9	1.31
April	45.5	85	23	1.76
May	5.9	94	30	.98
June	63.2	90	30	5.91
July	71.4	96	48	7.29
August	67.4	97	39	1.59
September	54.8	92	23	2.57
October	47.4	81	23	3.83
November	25.0	57	2	.00
December	Lost	36	—38	.28
				25.68

The rainfall for the year has been 5.90 inches above the average for ten years preceding, and .14 of an inch more than in 1900, which was a year of exceptional rainfall.

By years we give below the rainfall as recorded at this station beginning with 1892:

	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901
Rainfall inches	20.73	16.17	18.72	16.85	20.33	22.30	16.20	21.20	25.54	25.68

This gives an average annual rainfall of 20.37 inches for the period 1892 to 1901 inclusive; a minimum of 16.17; and a maximum of 25.68 inhcse

MONTHLY RECORD OF SUNSHINE.

The hours of actual sunshine, as given in the following table, are those as recorded by a Friez photographic sunshine recorder. No correction has been made for early morning and evening sunshine unrecorded. Probably about 12 to 15 per cent should be added to the results as given by the instrument:

SUNSHINE—1901.

Months	Total Hours		Hours—Daily Mean		Percentage of Possible Sunshine
	Possible	Recorded	Possible	Recorded	
January	279.0	111.9	9.00	3.60	40.00
February	287.1	143.9	10.40	5.14	50.20
March	369.0	180.9	11.90	5.83	48.90
April	407.3	175.2	13.58	5.84	42.70
May	466.3	298.1	15.00	9.61	64.80
June	475.0	192.0	15.80	6.40	40.40
July	480.2	257.5	15.46	8.30	53.50
August	441.8	248.0	14.23	8.27	57.90
September	378.3	211.5	12.60	7.05	55.80
October	337.5	195.0	10.89	6.29	57.70
November	281.6	119.8	9.38	3.99	42.80
December	267.1	69.9	8.60	2.26	26.30
Total and means	4470.2	2203.7	12.24	6.05	49.43

The total hours of recorded sunshine and percentages of possible sunshine for the three years have been as follows:

	1899	1900	1901
Total hours recorded	2166.85	2116.5	2203.7
Daily mean hours recorded	5.97	5.7	6.05
Percentage of sunshine	48.8	47.1	49.43

This shows a slightly higher percentage of sunshine for the past year than for the two preceding years.

BROME GRASS VS. TIMOTHY.

The results of experiments made with brome grass as compared with timothy for 1900 have already been published. (Bulletin No. 47, North Dakota Agricultural College, pp. 711-721.) In these experiments the superior quality of brome grass over timothy for a dry season was clearly shown. In order to find what the results would be in an average year, examination of the grasses from the plots were made during the past season. The results for brome grass are shown in the following:

	Date Cut				
	May 24	June 26	July 17	Aug. 16	Sept. 26
Height, inches	10.00	8.00	9.00	4.5	....
Yield per acre	5536.00	2496.00	2272.00	960.00	480.00
Dry matter per acre	1439.40	570.00	516.90	249.60	194.10

ANALYSIS OF BROME GRASS (PASTURE.)

	May 24	June 26	July 17	Aug. 16	Sept. 26
Water	74.00	77.16	77.25	74.00	59.56
Ash	2.33	2.55	2.69	3.05	4.70
Fat	1.65	1.39	1.55	1.87	2.80
Protein NX 6.25..........	6.19	3.23	3.08	4.92	6.49
Crude fiber	4.01	6.41	6.08	6.65	9.92
Nitrogen—free extract....	11.84	9.25	9.43	9.52	16.52
Totals	100.00	100.00	100.00	100.00	100.00

ANALYSIS FOR ABOVE (WATER FREE).

Ash	8.96	11.17	11.85	11.74	11.61
Fat	6.28	6.08	6.83	7.21	6.92
Protein NX 6.25	15.44	14.16	13.56	18.94	16.06
Crude fiber...............	23.79	28.08	26.38	25.58	24.54
Nitrogen—free extract	45.54	40.52	41.38	36.55	40.85
Totals	100.00	100.00	100.00	100.00	100.00

The yields per acre for the season, expressed in pounds, of the several constituents were as given below:

	May 24	June 26	July 17	Aug. 16	Sept. 26	Totals
Ash..............................	128.9	63.60	61.3	29.3	22.6	305.70
Fat..............................	90.4	34.60	35.3	1.8	13.4	191.70
Protein NX 6.25.................	222.2	80.77	70.1	47.2	31.2	451.47
Fiber............................	342.4	159.90	136.3	63.9	47.6	750.10
Nitrogen—Free extract	655.5	230.90	213.9	91.2	79.3	1270.80
Totals....................	1439.4	569.77	516.9	249.6	194.1	2469.77

TIMOTHY GRASS (PASTURE).

Two cuttings only were made of timothy, these corresponding to the first two for brome grass, May 27 and June 26. The heavy rains after this date completely drowned out the timothy, so that no further growth for the season was made. Brome grass in 1900 demonstrated its superior value to timothy in times of prolonged drought; and, again, in 1901, the results indicate that brome grass is superior to timothy in very wet land, or seasons of extreme rainfall.

The results of the two cuttings of timothy (pasture) are given below:

	Date Cut	
	May 27	June 26
Height, inches	8.5	9.0
Yield per acre, pounds	2560.0	1600.0
Pounds dry matter per acre	851.2	448.3

ANALYSIS OF TIMOTHY GRASS (PASTURE).

	May 27	June 28
Water	66.75	71.98
Ash	2.56	2.54
Fat	2.10	1.44
Protein NX 6.25	3.40	3.10
Crude fiber	7.80	7.46
Nitrogen—Free extract	17.39	13.48
	100.00	100.00

The analysis of the water free substance is indicated in the accompanying table together with the yield per acre:

	May 27		June 26	
	Per cent	Pounds per acre	Per Cent	Pounds per acre
Ash	7.71	65.6	9.07	40.7
Fat	6.31	53.7	5.14	23.0
Protein NX 6.25	10.22	87.0	11.06	49.6
Crude fiber	23.45	199.6	26.61	119.3
Nitrogen—free extract	52.31	445.3	41.38	215.7
	100.00	851.2	100.00	448.3

Comparing the brome grass yield for the season with that of timothy and we have expressed in pounds:

	Brome	Timothy
Total yield (green)	12244.0	4160.0
Dry matter	2970.0	1299.5
Ash	305.7	106.3
Fat	191.7	76.7
Protein NX 6.25	451.5	136.6
Fiber	750.1	318.9
Nitrogen—free extract	1270.8	661.0
	2969.8	1299.5

The brome grass yielded for the season 8084 pounds more of green feed than did the timothy; or, a difference in favor of the brome grass for pasturage much more marked than was the case for 1900, the season of prolonged drought.

BROME GRASS HAY.

Brome grass (bromus inermis), was cut for hay at two stages of development. The dates were July 8 and 17. On the first date the grass was not all headed out, about two-sevenths being as yet unheaded, the balance just in head. The average height of that not headed was about 26 inches; while the grass in head averaged about 36 inches in height. On July 17, the grass as cut was in the brown state of head, while the first cutting was in the purple. The fully headed grass, July 17, averaged about 38 inches high, while that not so far advanced averaged about 28 inches in height.

	Date Cut	
	July 8	July 17
Height, inches	26.36	28.38
Yield per acre	9440.00 pounds	12032.00 pounds
Dry matter per acre	3445.50	4314.70 pounds

This shows a gain of 919 pounds per acre of dry matter from July 8 to the 17th.

The analysis of the two lots of hay are shown below.

	Fresh Substance		Dry Substance	
	July 8	July 17	July 8	July 17
Water	64.56	64.14		
Ash	2.95	3.02	8.35	8.43
Fat	1.58	1.76	4.48	4.91
Protein NX 6.25	3.10	3.97	8.75	11.08
Crude fiber	10.47	10.90	29.58	30.40
Nitrogen—Free extract,	17.34	16.21	48.84	45.18
	100.00	100.00	100.00	100.00

The two samples above for 1901 do not show as high protein content as was found in the hay for 1900. The two seasons, however, were very unlike and the crop results were modified by these conditions.

Calculating the yields per acre for the several constituents, we have as follows:

	July 8—Pounds	July 17—Pounds
Ash	2.79	363.7
Fat	149.9	211.8
Protein NX 6.25	292.7	478.1
Fiber	989.0	1311.7
Nitrogen—Free extract	1633.2	1949.4
	3344.00	4314.7

These results come as a continuation of the experiments in 1901 of those undertaken in 1900 and already published. The results are all indicative of the high value of brome grass for both pasture and hay crop in North Dakota.

For the benefit of those who may not have Bulletin No. 47, issued by this department, I repeat the conclusions there presented regarding Brome grass:

CONCLUSIONS.

1. "Brome grass produced a fair amount of pasturage in the dry year of 1900 while timothy made very little growth.

2. "Animals prefer brome pasture to timothy as shown in their grazing for 1899, when there was an abundance of both grasses, and in 1900 we have like results.

3. "There was but little difference in chemical composition between pasture grass from brome and from timothy. The total yield per acre was much in favor of the brome grass.

4. "Brome grass made a fair crop of hay in 1900, while timothy failed.

5. "Brome hay contains about twice as much protein as timothy.

6. "Brome hay does not contain more fiber than the average for timothy grown in all parts of the United States.

7. "Brome grass sends its roots down deeper into the soil than timothy and furnishes a great mass of roots in the first foot of soil and hence the soil may be expected to blow less when plowed.

8. "Soils on which brome grass has been grown contain more organic matter and humus than those on which timothy has been grown.

9. "Brome grass is a better humus former than timothy and leaves the soil in better chemical and physical condition than does the timothy."

The conclusions above for 1900 are fully born out in 1901. In addition brome grass has demonstrated that in wet years, as well as in dry seasons, it is superior to timothy as a pasture or as a hay producer on the college grounds.

BROME HAY.

ASH ANALYSIS.

A sample of brome hay cut on the college farm July 9, 1900, contained 7.29 per cent of ash.

An analysis of the ash gave results as follows:

	Per Cent
Carbon	5.71
Sulfuric acid SO_3	5.77
Silica and sand	33.52
Potash K_2O	28.08
Soda Na_2O	2.34
Phosphoric acid P_2O_5	9.84
Iron Fe_2O_3 / Alumina Al_2O_3	2.58
Magnesia MgO	6.20
Calcium CaO	6.12
	100.16

ASH ANALYSIS OF WHEAT.

A sample of Fife wheat grown in the Red River valley, containing 2.26 per cent of ash, was analyzed with results as below:

	Per Cent
Carbon	Trace
Sand and silica	2.74
Iron Fe_2O_3 / Alumina Al_2O_3	1.00
Lime CaO	7.32
Magnesia MgO	8.91
Sulfuric acid SO_3	1.49
Phosphoric acid P_2O_5	48.84
Potash K_2O	18.51
Soda Na_2O	12.02
	100.81

FLOUR FROM ARNAUTKA WHEAT.

Considerable interest is manifested in the macaroni wheats and the flours produced from this class of wheats. Mr. F. R. Strong, of Scoville, N. D., sent to the laboratory a sample of flour produced from one of these wheats—the variety known as Arnautka wheat. This wheat he has been growing upon his farm since 1893, so that it has become thoroughly acclimated.

An examination was then made to determine the composition analysis is given below:

	Per Cent
Water	5.02
Ash	.85
Proteids, NX 6.25	15.69
Fat	2.16
Crude fiber	.74
Nitrogen—Free extract	75.54
	100.00
Total nitrogen	2.51

The results show this sample of flour to contain considerable more of proteids than are found in the average of our hard wheat flours.

An examination was there made to determine the composition of the proteids and the results are given as follows:

	Nitrogen	Proteids
Water soluble	.35	2.19
Salt soluble	.16	1.00
Gliadin	1.17	7.31
Glutinin	.75	4.69
	2.43	15.19
Loss	.08	.50

The total gluten, then, in this sample of flour, amounted to 12 per cent, which is about 20 per cent higher than that for average hard wheat flours. The gluten constituted 77 per cent of the total proteids, and the gliadin was about 61 per cent of the total gluten.

It is generally considered that the gluten of flour should constitute not less than 80 per cent of the total proteids, and that the gliadin should constitute from 60 to 65 per cent of the gluten.

Judged from the chemical analysis, the flour would be considered of excellent quality. In physical appearance, the flour seems somewhat harsher to the touch than the average flours, and in color it is much more creamy.

INFANT FOODS.

During the past year the following "Infant Foods" have been analyzed with results as shown in the accompanying table:

	Mellin's	Nestle's	Horlick's
Water	2.73	7.68	1.47
Ash	4.54	1.29	3.11
Proteids	9.56	9.31	14.13
Fat (ether extract)	.60	4.39	1.97
Starch and dextrine	31.05	38.31	30.92
Glucose	20.40	4.02	20.40
Sucrose	31.12	34.80	28.00
	100.00	100.00	100.00

An analysis was also made of a sample of Horlick's Tablets; but in this case no separation of the carbohydrates was made:

Water	2.85
Ash	3.43
Proteids	15.43
Fat (Ether Extract)	2.45
Carbohydrates	75.84
	100.00

PLASMON.

A new series of food products, in the form of a dry powder, known as plasmon, has been generally advertised. Several of these preparations are on the market, three of which we have examined. These are plasmon powder, plasmon biscuit, and plasmon chocolate:

ANALYSIS OF DRY SUBSTANCE.

	Plasmon	Plasmon Biscuit
Ash	7.72	1.78
Proteids	70.15	19.68
Fat	.28	10.02
Carbohydrates	21.84	68.52
	100.00	100.00

An analysis of the plasmon chocolate showed it to contain 21.10 per cent of proteids.

The manufacturers assert in their circulars "that one teaspoon-

ful of plasmon contains all the actual nutriment in one-quarter pound of the best beef."

They state further in regard to the biscuit that, "six of these biscuits contain the actual nutrition found in one-quarter pound of the best tenderloin of beef. This is a fact which has been proven by both chemical and physiological tests."

The average weight of the biscuits, for example, was 4.8069 grams; or, the weight of six biscuits would equal 28.8414 grams. These biscuits were found to contain 19.68 per cent of proteids; or, in one-fourth pound there would be 18.05 grams proteids; or, more than three times as much proteids are found in six of the plasmon biscuits.

That plasmon is a valuable food product need not be questioned; but misleading statements are not to the credit of the manufacturers.

BOILER SCALE.

Two samples of boiler scale have been analyzed, and as the results are of value in showing the composition of these products, we give the analysis below:

	Sample No. 1	Sample No. 2
Moisture	1.62	0.80
Silica SiO_2	7.87	32.83
Sulfuric acid SO_3	Trace	22.02
Phosphoric acid P_2O_5	.21	0.23
Carbon dioxide CO_2	16.16	1.85
Lime CaO	48.27	26.76
Magnesia MgO	8.11	6.90
Iron Fe_2O_3 / Alumina Al_2O_3	1.43	3.20
Alkalies	Trace	Trace
Volatile matter	16.30	5.41
	100.00	100.00

SOILS OF NORTH DAKOTA.

During the past twelve years a considerable number of soils, representing nearly all sections of the state, have been examined. Many of these samples represented typical soils from the several localities; and I have thought it advisable to compile the data for these analyses, heretofore published, where the samples appear to be representative of any considerable areas. I will first present the results of the physical examination of these soils so far as made.

PER CENT OF SOIL THAT PASSED THROUGH SIEVE WITH NUMBER OF MESHES PER SQUARE INCH IN SIEVE.

Soils From	No. Examined	Meshes or Openings Per Square Inch					
		100	80	60	40	20	10
Red river valley	8	41	47	57	72	93	99
James river valley	6	58	65	78	91	98	100
Sheyenne river valley	2	2	43	60	78	91	95
Devils Lake region	6	6	33	42	58	72	92
Turtle mountain region	5	5	47	56	67	88	97
Wells county	1	1	66	78	91	97	99
West of Missouri	2	2	34	56	74	88	92
Mouse river valley	1	1	82	90	98	98	100
South counties (east)	5	5	54	61	79	92	99
Means	...	46	52	62	79	91	97

Analysis of Soils from Different Localities Within the State.

	Red River Valley (21 Samples)	James River Valley (5 Samples)	Sheyenne River Valley (2 Samples)	Mouse River Valley (4 Samples)	Devils Lake Region (10 Samples)	Turtle Mountains (8 Samples)	Wells County (2 Samples)	South Counties (7 Samples)	West Missouri (2 Samples)
Insoluble silica........	59.00	65.53	55.73	65.53	66.59	74.79	79.05	66.97	73.37
Combined silica.......	8.15	10.40	8.38	9.34	5.04	5.30	6.03	10.72	5.60
Lime CaO	4.16	1.07	14.67	2.19	6.08	.77	.41	.96	.32
Magnesia MgO........	.81	.57	.93	.51	.61	.47	.28	.14	.43
Phosphoric acid P_2O_5..	.19	.27	.17	.18	.12	.14	.19	.25	.19
Sulfuric acid SO_3.....	.17	.03	.77	.35	.04	.06	.06	.16	.04
Iron Fe_2O_3............	3.69	3.09	2.44	2.78	2.38	2.73	2.90	3.36	1.68
Alumina Al_2O_3.......	3.11	3.44	2.43	5.20	2.19	2.79	2.01	2.99	3.79
Potash K_2O...........	.54	.48	.54	.34	.57	.55	.45	.45	.35
Soda Na_2O............	.73	.66	1.24	.88	1.12	.58	.63	.29	.49
Volatile matter........	19.30	14.13	13.61	11.85	13.23	12.16	8.00	13.69	13.50
	99.85	99.67	100.81	100.15	98.97	100.34	100.01	99.99	99.76

The results for many analyses of soils are not included in the above, since the samples in some cases were selected to determine specific points and the soils did not represent extended areas; and, in other cases, the history of the soil sample is not known well enough to justify its use in this case. The analysis of the sixty-five samples reported upon above, however, furnish data for judging of the soils of the state and clearly show all the soils to be naturally well supplied with the elements of fertility.

ANALYSIS OF SUB-SOILS.

A few samples of sub-soil representing the several sections of the state, have been analyzed. The results of the analyses may be of interest to our readers, and will show what the character of the material is, upon which our surface soil rests.

The following indicates by number the section of the state, from which the sample was taken:

100 Red River Valley.
101 James River Valley.
102 Sheyenne River Valley.
103 Devils Lake Region.
104 Turtle Mountain Region.
105 West of Missouri.
106 South Counties (East of Missouri River).

ANALYSIS OF SUBSOILS FROM THE COLLEGE.

	100	101	102	103	104	105	106
Insoluble silica	62.03	69.51	49.08	54.88	54.37	65.73	85.20
Combined silica	7.11	8.18	8.18	11.63	9.03	17.03	
Lime CaO	6.23	3.53	18.26	4.26	13.95	trace	.55
Magnesia MgO	1.49	.88	1.68	1.21	1.48	.63	.21
Phosphoric acid P_2O_5	.23	.13	.17	.19	.14	.17	.29
Sulfuric acid SO_3	.04	trace	4.41	.20	1.09	.12	1.06
Iron Fe_2O_3	4.84	3.81	2.30	1.52	4.14	1.00	2.24
Alumina Al_2O_3	4.77	3.46	1.96	3.65	3.07	3.63	2.73
Potash K_2O	.43	.55	.49	.43	.68	.51	.68
Soda NaO_2	1.14	.98	1.55	.58	.84	.24	.27
Undetermined and Volatile matter	11.62	9.07	10.92	21.45	11.21	11.04	7.38
	100.00	100.00	100.00	100.00	100.00	100.00	101.56

As further showing the character of the soils and subsoils, samples from the station experiment plats were taken at different depths and submitted to analysis. These samples represent the soils taken at a depth of 1 to 6 inches, 6 to 12 inches, two feet, three feet and four feet.

The result of the analysis is shown in the following table:

SOIL FROM STATION PLANTS.

	1 to 6 in.	6 to 12 in.	2 feet	3 feet	4 feet
Insoluble silica	64.07	59.51	52.09	43.83	34.83
Combined silica	3.53	9.86	15.18	17.43	23.78
Lime CaO	1.47	1.46	2.75	6.55	8.34
Magnesia MgO	.72	.42	1.23	.97	.45
Phosphoric acid R_2O_5	.21	.20	.19	.16	.15
Sulfuric acid SO_3	.31	.13	.25	.12	.25
Iron Fe_2O_3	4.32	4.26	5.20	4.40	4.14
Alumina Al_2O_3	5.67	7.39	7.28	7.29	8.68
Potash K_2O	.77	.63	.54	.63	.54
Soda Na_2O	.31	.40	.40	.33	.51
Volatile matter	16.62	12.45	11.88	14.49	15.35
Moisture	2.30	2.55	2.66	2.56	2.55
	100.30	99.26	99.65	98.76	99.55
Nitrogen	.37	.24	.075	.05	.016

These results show the soil to contain a good supply of the essential elements of fertility: phosphoric acid, potash, lime, etc. Even at a depth of four feet, there is 0.15 per cent of phosphoric acid and 0.54 per cent of potash.

SOIL FROM THE SUB-STATION AT EDGELEY, N. D.

A sample of soil representing the first foot, and another representing the second foot, or the sub-soil, from the experimental field on the Edgeley State Sub-Station, was analyzed with results as follows:

	Per Cent, First Foot	Per Cent, Second Foot
Silicates	82.45	85.10
Lime CaO	.65	.55
Magnesia MgO	.23	.20
Phosphoric acid P_2O_5	.20	.29
Sulfuric acid SO_3	.74	1.03
Iron Fe_2O_3	2.25	2.34
Alumina Al_2O_3	2.51	2.61
Potash K_2O	.61	.72
Soda Na_2O,	.57	.26
Volatile matter	9.70	6.95
	99.91	100.05
Humus	2.36	1.30
Nitrogen	0.26	0.10

From the above it will be observed, that while this soil is well supplied with mineral plant food, it is deficient in organic mat-

ter, and in humus content. It is believed that the chemical conditions of this soil could be much improved by a good system of crop rotation.

SOILS FROM STATION PLATS.

Soils from four of the rotation plats on the station grounds have been analyzed, and the results are of interest as showing the chemical condition of these soils at the end of ten years' continuous wheat cropping since the college began the experiments. The same land had been in continuous wheat, so far as known, since 1883.

	Soil 1 to 10 inches				Bottom of second root	
	Plat 1	Plat 2	Plat 24	Plat 25	Plat 2	Plat 25
Insoluble silica, Combined silica	70.15	70.57	70.71	72.26	68.53	64.24
Lime CaO	1.08	1.39	1.07	1.19	.97	2.80
Magnesia MgO	.34	.50	.44	.68	.32	.51
Phosphoric acid P_2O_5	.27	.29	.38	.39	.24	.33
Sulfuric acid SO_3	.15	.14	.21	.18	.15	.13
Iron Fe_2O_3	5.10	4.87	4.33	4.66	5.55	5.62
Alumina Al_2O_3	6.29	6.82	5.49	6.09	7.36	7.63
Potash K_2O	.79	.82	.78	.96	.57	.59
Soda Na_2O	.40	.59	.58	.56	.17	.16
Volatile matter	14.95	14.81	13.45	12.90	7.80	9.89
Moisture	10.77	10.17	11.23	10.61	9.00	8.38
	100.29	100.96	99.67	100.48	100.68	100.58
Nitrogen	......	.36	......	......	.13	....

The results given in the preceding table indicate that, the soil in the series of plats used in crop rotation has similar composition for the two ends of the field.

An analysis of the soil, taken to the depth of ten inches, from the same field, in 1891, gave results at that time as follows:

	Per Cent
Total silicates	69.11
Lime CaO	.88
Magnesia MgO	.51
Phosphoric acid P_2O_3	.23
Sulfuric acid SO_3	.14
Iron Fe_2O_3	4.59
Alumina Al_2O_3	2.61
Potash K_2O	.57
Soda Na_2O	.58
Volatile matter	20.98
	100.20

In 1891, when the first sample was taken, the field had not been laid out in plats; and the sample represented not any single plat, but portions taken at several points over the field.

SOIL INVESTIGATIONS.

A large amount of analytical work has been done in connection with a study of soils, especially along the line of determining nitrates, humus, and the relation of humus to mineral constituents of the soil, available for plant food. This data is reserved for a future bulletin.

Bulletin 47, published by this department during the past year, contains the result of work done for the preceding year on "Humus and Soil Nitrogen." I repeat here the conclusions that were given at the close of that bulletin.

CONCLUSIONS:

1. "If you would keep the soils in the best chemical and physical condition, there must be practiced such a system of rotation that there shall be included in the rotation humus producing and humus consuming crops.

2. "Two humus producing, to three humus consuming crops should, with proper cultivation, maintain the soil in its highest state of productivity.

3. "Soils fertile by nature, such as the Red River Valley soil, should, under a system of agriculture, as indicated above, yield goods crops, without the aid of commercial fertilizers for a thousand years. This assumes the proper use of all barn manures and the prevention of unnecessary loss from the soil.

4. "A proper system of crop rotation should result in enriching the surface soil with plant food rather than in depleting it, and especially should this be true for nitrogen and humus.

5. "The first foot of soil in the Red River Valley contains enough plant food for at least 1,400 maximum crops, without drawing upon the supply of food material in the second foot or below.

6. "The continuous growing of wheat, or other grains, or cultivated crop, rapidly depletes the organic matter from the second six inches of soil.

7. "The growing of clover and peas in a crop rotation causes a marked increase in the organic matter and humus in the soil, in both the first and second six inches. These plants are also nitrogen accumulators.

9. "Land in crop rotation on which corn was grown in 1899, and wheat was grown in 1900, showed more than twice as much water in the first six inches, on July 14th, as found in soil continuously in wheat. In the second six inches there was sixty-three per cent more water. The yield of wheat was more than seven times as great.

10. "On July 14th the field on which corn had been grown the preceding year, contained 39 per cent more nitrates than for the continuous wheat field. On July 30th, the difference was even more marked being 61 per cent more of nitrates.

11. "Nitrifying bacteria in bare summer fallow were not found in the soil below two feet; probably not below eighteen inches.

12. "Nitrates were found in greater abundance at a depth of seven feet than at a depth of one foot.

13. "For every pound of nitrogen removed from the soil by wheat, we have lost from four to six pounds by other ways, where wheat has been grown continuously.

14. "Soils on which wheat has been grown continuously since 1883, are found to be in bad condition, chemically and physically. They do not retain water well in the cultivated portion, and failed to mature a crop of wheat in the dry season of 1900.

15. "The available plant food and the principal feeding ground of the wheat roots seems to be in the first eight inches of soil.

16. "A soil may contain a good supply of available plant food in the first eight or ten inches, and enough water lower down, but within reach of the wheat roots, and yet fail to produce a crop, literally starve, surrounded by an abundance of plant food for want of moisture in the first eight inches, to dissolve the food for the use of the plant.

17. "Plowing under a green crop does not produce as beneficial results as come from plowing grass lands. Plowing under a green crop leaves the organic matter in a mass and not uniformly distributed throughout the soil.

18. "After grass in a crop rotation, the soil shows a large increase in amount of organic matter but less than two-thirds as much as is found in adjoining fields of native prairie soil.

19. "Soils filled with a mass of grass roots furnish, in all parts of the soil, a uniform supply of organic matter, which by gradual decay, furnishes the soil humus. This humus, reacting upon the mineral constituents of the soil, seems to aid in liberating and rendering available this plant food.

20. "Newly broken soils do not blow. It is only after they have been cropped for a series of years, that soils begin to blow badly.

21. "The great mass of fine roots intertwined about the particles of soil in the virgin prairie prevented the soil from blowing. This mass of roots acted as pins to hold the soil in place. The decay of these fine roots removes the binding agents and permits of blowing. This is quite common on lands not well cultivated and in wheat continuously.

22. "Adopting a system of rotation which includes grass, will prevent the blowing by again returning to the soil the binding agents, the fine grass roots which serve as pins to hold the soil particles in place.

23. "Brome grass seems to put the soil more nearly in the condition of native prairie than timothy, while clover acts as a nitrogen gatherer to replace the legumes, common on virgin soil.

24. "The system of agriculture most nearly ideal for maintaining soil fertility would be one with two years in grass followed by cultivated crop, then two years in grain crops, making a five years' rotaton, then to be repeated."

FOOD ANALYSIS.

A large number of native food products are being analyzed, the results of which are not ready for publication at this time, but will form a part of a future bulletin from this department.

ACKNOWLEDGMENTS AND NEEDS.

During the past year, Mr. L. B. Greene and Adele Shepperd have been the assistants in the laboratory, dividing their time between college and station duties. Much of the analytical work has been done by my assistants in a most satisfactory manner.

The great need of the department is a laboratory suitable for doing station and college work in a manner commensurate with the demands made upon it for work. I trust that some arrangements may be made to give the department such quarters as are needed.

Respectfully submitted,

E. F. LADD,
Chemist.

DEPARTNENT OF BOTANY.

To Director J. H. Worst:

Sir: As in previous years the field work of this department has been chiefly limited to observations and experiments upon cereals and potatoes. Some observations, collections of specimens, and limited experiments have been made upon other types of plant study than those here reported, but are to be considered as matters of preliminary work.

WORK UPON THE WHEAT PLANT IN 1901.

The Selection of Wheat from the Individual Head: This is the fourth year upon this line of work, but the results obtained this season are of slight, if any value. The long continued drouth just following seeding time caused great irregularity in the first growths from the individual seeds, so that the observations made upon the growing plants are of slight comparative worth. Again, just previous to harvest time, a condition of blight struck the crop. The heads filled very irregularly. For this reason also the experiment was in part vitiated for comparative purposes. There is now sufficient data on hand to justify the publication of a bulletin upon this subject of selection from the individual head and plant. The work has emphasized to me the importance to the grain grower that he should use every economic method of seed selection which may tend to improve the strain desired. Summarizing the work of the four years, the actual records of the different features of growth indicate, in general, that: (1.) There is much difference in the development of the crop from individual plants. (2.) That even in the same head perfect grains of large size and greatest weight show some advantage over perfect grains of smaller size and of less weight. This is but further evidence indicating that ordinary methods of seed grading through the use of the fanning mill must tend to proper crop results. (3.) It is of the greatest importance that the grains sowed should be of high grade of quality. Indeed so far as the general farmer is concerned, I feel sure that the greatest importance should be attached to this matter of perfect quality of seed. An uninjured seed insures a strong first growth, which, other conditions being equal, is necessary to a large yield. (4.) The next point of importance which shows itself plainly is that a proper and even depth of seeding has very great effect upon the growth of the wheat plant. The results again

this year show that, when a grain of wheat is properly imbedded in the soil, the depth for best crop production is not far from one inch of cover.

Selection of Wheat From the Bin: The work of a comparative test of large and small grains of perfect form selected from the bin was continued as in previous years. The observations upon strength of growth and other comparative matters correspond closely to those of the season of 1900. The data given in the eleventh annual report, pp. 30 and 31, I think furnish a correct idea of what is to be expected in this line. If the individual plants are considered, one may often find growths from the small grains which excel in strength and in quality of seed produced the average plants from the large select grains. These, however, I believe are to be considered as exceptions due to special strains within the variety. When the growths and products from all the grains are compared and arranged, it is found that the results are quite uniformly favorable to the large selects. It is to be remembered that in this work only perfect or ideal grains were used for seed, hand selected for size and weight, the average weight of the large grains being approximately twice the weight of the small selects. This experiment places much emphasis on the assertion that, in matters of yield of wheat, two very important factors are indicated in the terms varietal strain and perfection of seed quality. The latter feature may be easily governed by the farmer through ordinary methods. It is seen to be a matter of great importance when it is shown that the perfect small grains were excelled in yield by the perfect large grains approximately but 10 per cent. This difference is, perhaps, due to two elements: First, difference in strain; that is, the average small grain in a bin is apt to be from a parent plant which belonged to a strain which is in the habit of producing small grains. Second, to actual difference in strength to force a proper growth. Upon these points, see also results from the experiments upon selection of large and small grains from individual heads in this report p— and in eleventh annual report p. 30.

The Growth of Wheat From Immature Seed: The work of testing the value of mature and immature wheat for seed purposes was continued again this season. The results are very plain. Three samples of grain were saved from the crop of 1901 as follows: No. 1. Very immature. The grains were in the milk stage. No. 2. Quite immature. The grains were in a soft doughy stage. No. 3. Thoroughly mature. The grain was allowed to stand until dead ripe, one month after the first cutting. The straw was cut by hand in 1900 and the grain was cured in the head without exposure to weather, thus insuring uninjured embryos. A test of germination strength was made in a Geneva germinator on date of April 20, 1901, with the following results per 100 grains: No. 1. Fifty strong, forty-two medium and

eight weak growths. No. 2. Sixty-two strong, thirty-six medium and two weak growths. No. 3. Fifty strong, thirty-four medium and fourteen weak growths, and two dead grains.

It is again seen that wheat which is not thoroughly mature may under good conditions show a higher percentage of germination and a more rapid response to moisture than thoroughly mature grain. The results at harvest and the growth from the start in the field, however, show the immature seed in unfavorable comparison. All seeds, 800 of each type, were planted under like conditions on the date of April 30, and were harvested by hand pulling on the date of August 1. The season following seeding time was a trying one to young plants, and those from the mature seeds showed from the start a very much stronger growth. A difference in width of leaf surface and height was easily seen at a distance. The following harvest records show what was done by each group of grains:

No. 1 produced 326 stools, the dried heads from which weighed 552 grams.

No. 2 produced 433 stools, the dried heads from which weighed 943 grams.

No. 3 produced 575 stools, the dried heads from which weighed 1,402 grams.

While the weak, immature grains readily gave a high percentage of growths in the germinator, over 50 per cent failed to produce mature plants in the field under the trying conditions of a spring drouth.

On the Use of Injured Wheat for Seed Purposes: The very rainy autumn of 1900 injured the quality of much of the grain harvested in the state. The injury, in most cases, was primarily due to the influence of water upon the seed after maturity. Much of the grain was wet for a long time in the shock or stack. Some of it was thrashed damp and remained damp and soft in the bin, subjected to freezing and thawing and yet other samples were injured by heating in the stack or bin.

Some hundreds of samples were sent to the station for examination, the senders asking for a report upon the value of the samples for seed purposes. In all 560 samples of wheat and flax were tested in the laboratory to determine their seed value; and letters were written giving advice in the premises. It is unfortunate that there are many farmers who have a general impression that grain which is rejected upon the market may yet be used with good success for seed purposes. The experiments published by this department in Bulletin No. 13, April, 1894, were very strongly against this proposition; but the fine lot of injured samples on hand last spring gave an opportunity to test the matter more exactly. The following method was followed. Each sample of seed was hand picked so as to exclude broken and shriveled grains which would ordinarily be removed in the process of

grading or cleaning by the fanning mill. Germinator tests were then made in duplicate, using 100 grains for each test. In considering these tests each grain was examined, and the growth listed as strong, medium, weak, or dead, according to the results. This, together with a careful inspection of the general character of the grain, allowed us to make a judgment as to the value of each sample for seed. A number of injured samples were saved for trial in the experimental garden. The accompanying table gives the characteristics of these samples, and the yields from the same as indicated in stools matured, and the weight of clipped heads. All were planted on April 25, the grains being placed one and a half inches deep, one inch apart in the row and ten inches between the rows. Weeds were kept pulled and all plants were harvested by pulling upon date of July 30th. After curing a few days, the heads were clipped off and cured in paper sacks. When thoroughly dried, these were weighed. This weighing was done at two different dates. The averages of these two weighings furnish the figures given in column seven of the table. Eight hundred grains were planted in each bed. In order to test the question of injury more certainly, some samples were hand picked into three lots of 800 each. These are listed as (a), (b) and (c) in the table. Column (3) explains the type of each. (See table next page.)

The results from the experiments give a number of interesting facts, though the drouth following the date of seeding was intense. It seems, indeed, that the drouth was favorable to the soft seed. Many such came up quicker than the hard selects. Such soft seeds, however, were found to decay quickly in soil purposely made quite moist, while the hard seeds survived. The yields in the field from such injured seed for one season should not therefore be taken as a criterion. The reason that the soft seeds seemed to fare better than the hard ones was probably due to the fact that the soil was so dry that it could not furnish sufficient moisture to properly start a hard dry seed, while the soft seeds were actually favored by the dryer conditions. The latter certainly would have tended to early decay in a moist soil. Usually the number of stools and the yield seemed to follow rather closely upon what would be expected from the laboratory germination test; but it is interesting to observe that the growths in the field were much less in number than indicated by the germination test. Upon this point, compare the per cent of germinations given in column six with those under the term total in column four.

A Table for the Comparison of the Value of Different Samples of Injured Wheat for Seed Purposos in 1901.

Column 1	Column 2	Column 3	Column 4					Col. 5	Col. 6	Col. 7
No. of Sample and Address of Sender	Kind of Wheat	Type of the Injury and Noticeable Characteristics	Germination Test					No. of Stools in Field at Maturity	Per Cent of Grains which Matured Plants	Weight of Dried Heads in Grams
			Strong	Medium	Weak	Dead	Total			
1—J. K. Knight, Grandin	Blue Stem.	Bleached some	4	31	65	..	100			
(a)	Blue Stem.	800 best amber colored grains	..	..	..	..	...	480	60	855
(b)	Blue Stem.	Extra large but weathered grains	..	..	..	..	...	517	64	1032
(c)	Blue Stem.	800 grains of average size and quality	..	..	..	..	...	530	66	1038
2—M. Kanna, Lidgerwood	Blue Stem.	Shriveled, dark in color and soft	6	21	64	9	91			
(a)	Blue Stem.	Best grains in the sample, 800	..	..	..	..	...	471	58	967
(b)	Blue Stem.	800 largest grains much bleached	..	..	..	..	...	421	52	946
(c)	Blue Stem.	800 grains of average size and quality	..	..	..	..	...	402	50	600
3—Asa Sargent, Caledonia	Mixed	Was damp and hot in bin; shriveled	4	23	59	14	86			
(a)	Mixed	800 best select grains	..	..	..	..	...	502	62	1372
(b)	Mixed	800 as badly bleached as possible	..	..	..	..	...	397	49	882
(c)	Mixed	800 grains of average quality	..	..	..	..	...	437	54	946
4—George Hexom, Hickson	Blue Stem.	Size and color good	7	25	65	22	98			
(a)	Blue Stem.	800 best grains in sample	..	..	..	..	...	553	69	1142
(b)	Blue Stem.	800 large much bleached grains	..	..	..	..	...	574	71	1172
(c)	Blue Stem.	800 of average quality	..	..	..	..	...	578	72	1292
5—W. O. Pickard, Niagara	Fife	Quite badly sprouted; soft	1	34	54	11	89			
(a)	Fife	800 best, soft appearing	..	..	..	..	...	637	79	1247
(b)	Fife	800 large, soft grains	..	..	..	..	...	482	60	985
(c)	Fife	800 of average selection	..	..	..	..	...	434	54	934
6—J. Schaefer, Cashel	Fife Mixed.	Weak sample, some sprouted	7	19	74	..	100			
(a)	Fife Mixed.	800 best grains	..	..	..	..	...	457	58	1016
(b)	Fife Mixed.	800 poorest living grains	..	..	..	..	...	415	51	1048
(c)	Fife Mixed.	800 average selects	..	..	..	..	...	475	59	1132
7—J. C. Stout, Gardner	Blue Stem.	Size and color rather good	36	38	23	3	97			
(a)	Blue Stem.	800 best amber colored grains	..	..	..	..	...	593	74	1254
(b)	Blue Stem.	800 large bleached grains	..	..	..	..	...	533	66	1388
(c)	Blue Stem.	800 grains of average quality	..	.	..	..	...	518	64	1187

8—B. F. Campbell, Conway	Fife	Light, shrunken grain; 800 grains of average quality and size	13	43	40	4	96	512	64	1092
9—Price Brothers, Buchanan	Mixed	800 grains of average quality and size, dark amber, irregular in weight	12	31	53	4	96	398	49	1234
10—H. E Styles, Seymour	Blue Stem	Rather good color and size; 800 grains average quality and size	20	39	33	8	92	439	54	1181
11—Russell Mill Co., Jamestown	Mixed	Color fairly good; 800 grains of average quality	33	33	32	2	98	476	59	1159
12—Price Brothers, Buchanan	Mixed	Color and size fair; 800 selected amber colored grains	21	38	35	6	94	447	56	1185
13—O. W. Mathiesen, Wyndmere	Mixed	Wet in stack, but dry in bin; bleached	4	43	39	14	86	403	50	1195
14—A. Isenberger, LaMoure	Fife	Minnesota, No. 163, weak bleached sample, wet in stack	18	43	38	1	99	518	64	1491
15—Gray & Campbell, Sheldon	Blue Stem	Rather weak, bleached and sprouted some; 800 average grains	12	33	46	9	91	393	49	1115
16—Gray & Campbell, Sheldon	Blue Stem	Pedigreed Blue Stem, very weak; much bleached	9	36	50	5	95	432	44	1032
17—Gray & Campbell, Sheldon	Blue Stem	Called Salzer's Marvel, sprouted; 800 best grains	7	30	57	6	94	390	48	1190
18—Gray & Campbell, Sheldon	Blue Stem	Same as last; 800 large, soft grains otherwise sound	10	39	48	3	97	501	60	1214
19—College Farm	Blue Stem	Weak sample; grain of small size	6	35	53	6	94	387	48	1299
20—Gray & Campbell, Sheldon	Blue Stem	Grains selected of average size and quality	10	40	49	1	99	520	65	1218
21—S. Classon, Gardner	Blue Stem	A strong, clean sample of soft appearance; 800 best selects	35	28	35	2	98	521	65	1370
22—R. F. Brekke, Edgeley	Fife	Grains of large size, but rather soft in appearance	6	26	49	19	81			
(a)	Fife	800 best grains in sample	..	..	..	..	...	602	75	1424
(b)	Fife	800 sound, soft, bleached grains	..	..	..	..	...	497	62	1424
23—College Farm	Blue Stem	Good, strong seed	30	45	23	2	98	517	64	1358
24—Carl Peterson, Valley City	Mixed	Poor seed, had been wet and was slightly musty	13	29	15	43	57	344	43	957
25—H. Goehl, LaMoure	Fife	Rather large, soft and slightly damp	4	23	54	19	81	511	63	1387
26—D. L. Wellman, Frazee City, Minn.	Fife	Wheat of light weight, good color, but shrunken and hard	30	27	38	5	95	406	50	1084
27—Russell Mill Co., Jamestown	Mixed	Sample hard and of good color	27	40	30	3	97	428	53	1340
28—H. F. Tufts, Argusville	Mixed	Large seed, has been wet and is soft; 800 best seed selected	0	15	18	67	33	220	27	969
29—College Farm	Blue Stem	Good, strong sample of seed	..	..	..	..	...	458	57	1424
30—F. E. Vorachek, Conway	Blue Stem	Grains of this sample were much bleached and sprouted some	.	43	31	26	74	66	8	285
31—Morton & Co., Fargo	Fife	This wheat was of good color, but irregular in size of grains	65	0	20	15	85	386	48	1256
32—R. Brealie	Fife	A musty and considerably sprouted sample	0	0	31	69	31	244	30	823
33—H. H. Walland, McCanna	Fife	A good, plump berry, which appears somewhat bleached	30	37	29	4	96	441	55	1225

The Growth of Wheat in the Field Compared With Laboratory Germination Tests: The following table is self explanatory. Only one sample, No. 13 of the table produced a greater number of stools in the field at harvest time than the germinator test indicated. One hundred grains per sample were used in each of the tests.

Sample	Laboratory Test					Stools Matured in the Field
	Strong	Medium	Weak	Dead	Total	
1—Joseph Bina. Conway......	3	40	52	5	95	69, or 26 less than laboratory test
2—A. L. Peart, Embden.......	1	19	19	61	39	33, or 6 less than laboratory test
3—Sven Anderson, Rugby.....	9	52	32	7	92	82, or 10 less than laboratory test
4—G. B. Clifford, Grand Forks	15	45	31	9	91	77, or 14 less than laboratory test
5—E. S. Tyler, Fargo..........	22	48	26	4	96	74, or 22 less than laboratory test
6—M. Bliss, Lidgerwood......	12	22	44	22	78	60, or 18 less than laboratory test
7—G. C. Holden, Thompson...	25	25	25	25	75	65, or 10 less than laboratory test
8—H. A. Britton, Casselton....	0	7	31	62	38	29, or 9 less than laboratory test
9—Iver Thompson, Portland..	..	..	..	..	83	71, or 12 less than laboratory test
10—R. B Montgomery, Inkster.	0	26	46	28	72	68, or 4 less than laboratory test
11—S. J. Sandness, Larimore...	9	22	32	37	63	46. or 17 less than laboratory test
12—J. M. Thompson, Ayr.......	7	11	26	56	44	41, or 3 less than laboratory test
13—T. H. Bubach, Griswold....	3	11	27	59	41	42, or 1 less than laboratory test
14—E. T. Curtiss, Fargo........	12	22	64	2	98	75, or 23 less than laboratory test
15—Unknown, Jamestown......	9	15	58	18	82	70, or 12 less than laboratory test
16—John Muir, Inkster.........	10	19	44	27	73	59, or 14 less than laboratory test
17—O. P. Dahlien, Kindred.....	42	22	27	9	91	58, or 33 less than laboratory test
18—M. C. Fitzgerald, LaMoure.	17	25	55	3	97	71, or 26 less than laboratory test

Summary: (1.) Field conditions in 1901 were distinctly less favorable for the growth from the seed than those which are given by the common Geneva germinator used at ordinary room temperature. The soil remained cold and dry for over one month following seeding time. Many seeds which would have been otherwise good died. (2.) In the eighteen samples tested, the difference between the number of stools matured in the field and the number of sprouts per hundred grains which grew in the germination tests was on the average approximately twelve. (3.) The smallest single difference was thirty-three growths in favor of the germination pan. (4.) This experiment confirms previous observations upon this subject. For the wheat plant the Geneva germinator will usually produce fair growths from some seeds which are too weak to produce plants under field conditions. (5.) This experiment and those connected with the study of the use of injured wheat and flax for seed indicate quite plainly that properly conducted germination tests are of much value to farmers. If there is any doubt of the viability, one cannot afford to sow large acreages with such seed. This is especially true in regard to flax, a seed which may be badly damaged without much change in appearance. Flax may also vary greatly in color and yet possess good strength for growth.

WORK WITH FLAX IN 1901.

Germination and Field Tests of Injured Flax Seed in 1901: A number of seeds of average size and quality were taken from each of many samples of injured seed sent to the college during the spring. Eighteen samples of varying character were selected from these upon which to make comparative trials to determine the efficiency of germinator tests. One hundred seeds from each sample were tested in a special germinating pan for flax seed. Eight hundred seeds from each were planted on May 24th in beds so that the individual seeds were approximately one inch deep, one-fourth inch apart in the row, and ten inches apart between the rows. The crop was harvested by pulling on September 4th.

TABLE SHOWING GERMINATOR TESTS OF FLAX SEED IN CONTRAST WITH TESTS OF THE SAME TYPE OF SEED IN THE FIELD.

Sample	Character of Injury	GERMINATOR TEST					Plants matured in field	
		Strong	Medium	Weak	Dead	Total	Number	Per Cent
1—A. F. Miller, Wagar.	Brick red, due to heating in bin	3	8	26	63	37	3	3.0
2—W. O. Pickard, Niagara.	Had been damp; rather dark brown in color.	0	24	48	28	72	93	12.0
3—W. O. Pickard, Niagara.	Brick red, due to heating while damp......	4	20	48	28	72	105	13.0
4—Gray & Campbell Sheldon.	Light weight, dark colored, weak seed.....	0	11	63	26	74	47	6.0
5—Gray & Campbell Sheldon.	Poorest living seeds in last sample	..	..	..	..	..	50	6.0
6—Gray & Campbell Sheldon.	Seeds of average quality and size, as above...	..	..	..	..	..	55	6.5
7—G. Miller, Litchfield.	Very dark colored; not recommended........	7	12	14	67	33	81	10.0
8—William Ross, Fargo.	Dark colored, weak and scaly	..	20	32	48	52	76	9.5
9—H. H. Walland, McCanna.	Large plump, well-colored seeds............	91	..	..	9	91	234	29.0
10—Iver Thompson, Portland.	Immature, dark, scaly; 800 darkest...........	40	14	14	32	68	none	....
11—P. P. Lee, Minot.	A heated sample; 800 large, red seed.......	12	16	12	60	40	none	....
12—P. P. Lee, Minot.	800 best seeds in sample	42	14	16	28	72	33	4.0
13—G. A. Luce, Hope.	Slightly dark, some immature; injured.....	68	14	8	10	90	65	8.0
14—M. L. Elken, Mayville.	Light weight; color good..................	26	61	9	4	96	78	9.7
15—Kraabel & Co. Hope.	Light weight; dark, scaly, immature.....	..	28	52	20	80	no crop	....
16—J. M. O'Neal, Grand Forks.	Size normal; color good	56	22	10	12	88	109	13.0
17—A. L. Holcomb, Minnie Lake.	Brick red in color; had been heated..........	2	26	30	42	58	no crop	....
18—Jas. Scott, Hope.	Immature; all dark, scaly	0	1	7	92	8	no crop	....

Summary. (1.) Intense drouth following seeding time lessened the number of plants produced in the field, even by seed of best quality. (See for e. g. No. 9 of table.) A surprisingly low number out of the 800 seeds succeeded in producing plants to maturity. The highest per cent of growth represented in these experiments was 29.

(2.) Flax which has been damp and more or less heated takes on a brick red color. Such flax is of very poor seed value. (See samples 1, 3, 11 and 12 of table.)

(3.) Immature scaly flax was worthless in the soil condition of the past season. (See samples 10, 15 and 18 of the table.)

Flax Wilt: A large part of the time allowed for investigation has been given to a study of the life habits of the parasitic fungus which produces this disease. Many of the experiments planned were successful in throwing light upon the matter. The fungus is a species of fusarium, and like many of its relations shows marked ability to spread through and develop in the soil. For further information upon the work accomplished, see the preliminary report in eleventh annual report of this station, page 45, and Bulletin No. 50 upon "Flax Wilt and Some Minor Problems Affecting Flax Growing."

Flax Selection in 1900 and 1901: Realizing how important an element intelligent selection has been in the improvement of garden plants, an effort has been made to answer the question: Can flax be improved by the selection of seed from individual plants? The seed for twenty-nine tests was selected from various fields during the season of 1900. Besides a number of selections made because of apparent botanical variations noticed, such as leaf width, mode of branching, flower characters, etc., others were made for the purpose of contrasting such features as earliness versus lateness of maturity, long stems versus short stems, even ripening versus irregular ripening, strength of stem versus weakness of stem, etc. The product of each plant was kept separate and was planted upon the same date in 1901, under good conditions for comparison. The results give marked assurance that flax will respond very readily to proper methods of selection. (For the details of these experiments see Experiment Station Bulletin No. 50, now in course of publication.)

Shallow Versus Deep Planting of Flax: In the eleventh annual report, pages 44 and 45, some results are given from an experiment in which different samples of seed flax were used for planting at different depths. This gave opportunity to observe the effect upon after growth. A study of such growths leads to the conclusion that deep planting was always detrimental upon all dates of planting tested. The injury due to planting deeper than one and one-half inches was always apparent upon the after growth. The growth of flax in the field throughout the Red River Valley was especially weak in starting from the seed during the

spring of 1901. There were many total failures over large areas. In a number of cases I was called upon for a possible explanation. Very often I found that the seed used had been of rather poor strength, but in nearly all cases the chief cause of failure, when failure to produce a stand was total or nearly so, I found to be due to deep planting. Many farmers used summer fallowed land upon which to sow flax. The soil was light, loose and deep. The drills when set as shallow as possible sank deep into the soil. Very much flax was put down four or five inches. In the experiment just cited, in 1900 it was proved that the best flax seed cannot force the seed leaves above the surface of the ground when planted to a depth of from four to four and one-half inches, at least not in sufficient strength to make an aftergrowth. I believe this is a most important question to flax growers. All my observations cause me to believe that the seed bed for flax should be as firm as possible and that the depth of planting should if possible not exceed an inch of dirt cover.

WORK WITH POTATOES IN 1901.

The work of potato selection from the vine was continued in 1901. Fourteen experimental plantings were made, including selections from seven varieties. The heavy rains in July did much damage, making a part of the experiment of slight use for comparative purposes. The general results bear out the conclusions in Bulletin No. 30 and those cited in previous reports. There is now sufficient data collected covering the work with potatoes to warrant the publication of a bulletin of general information. Continuing the accumulation of facts upon the question of breeding, the following point may be recorded:

(1.) It is not easy in selecting to develop shape or form away from what may be called the normal type of the variety. For example, one must not expect to raise round tubers from a tuber which happens to be round, if found in a hill which normally belongs to a strain which habitually produces long or linear formed tubers. A tuber which, for example, happens to have a particular shape because of some mechanical condition of the soil, cannot reasonably be expected to produce tubers like itself in shape when planted in soil of normal mechanical type.

In regard to the stem and tip end question, the following summaries are interesting:

1. The stem ends excelled in number of stalks per hill thirty-one times.

2. The tips excelled in number of stalks per hill twenty times.

3. The tips and stem ends were equal in number of stalks per hill twenty-nine times.

1. The stem ends excelled in number of tubers per hill forty-four times.

2. The tips excelled in number of tubers per hill twenty-nine times.

3. The tips and stem ends were equal in number of tubers per hill seven times.

1. The stem ends excelled in weight per hill forty-four times.

2. The tips excelled in weight per hill twenty- nine times.

3. The stem ends and tips were equal in weight per hill seven times.

The number of hills thus contrasted was eighty.

The total weight of tubers from stem ends was 3,399 ounces.

The total weight of tubers from tips was 3,290 ounces.

The average weight per hill from stem pieces was 84.93.

The average weight per hill from tip pieces was 82.2 ounces.

The approximate difference per hill was thus 2.7 ounces in favor of the pieces from the stem ends. In 1900 this average difference was approximately three ounces per hill in favor of the pieces from the tips.

The general conclusion upon this matter of potato cutting drawn from the experiments conducted for several years must be that the two ends of a potato tuber are practically equal in value for planting purposes.

Root-Fusion in Potatoes: Tests upon this question were placed upon a more exact and extended plan than that which was reported upon in the eleventh annual report, page 42. An attempt was made to associate seed pieces from varieties of essentially the same life period (earliness) in the same hill. The varieties placed together were of such distinctive features that any fusing of characters dependent upon root-fusion or grafting might be apparent. The method of associating the pieces planted was as in 1900.

Twenty hills were planted in each experiment, and the following pairs or combination tubers were made:

Group No. 1. Triumph and Six-weeks, Triumph and White Ohio, Triumph and Red Russet, Triumph and Early Ohio.

Group No. 2. Thoroughbred and Rural New Yorker, Thoroughbred and Maine crop.

Group No. 3. Freeman and Burpees Superior, Freeman and Thoroughbred.

Notes: Generally both pieces produced stalks. These were usually quite distinctive. The difference between the varieties was usually quite apparent, either in stems, flowers, or the young tubers just setting. At digging time one kind of tuber and vine often quite predominated in individual hills to the exclusion of those of the associated variety, but such tubers show no essential variation from type. There appears to be no root grafting or fusion between varieties, at least none could be found during the earlier periods of growth nor at digging time.

If potatoes may thus tend to cross breed, there is no appearance in the first year growth which would confirm the idea. Some tubers from the different groups have been saved for a second test. If, from a single one of these, a growth different from either parent or a mixture of tubers should result, the old thesis "mixing in the hill" might have some evidence to stand upon.

MISCELLANEA.

Vitality of Weed Seeds Planted Different Depths in the Red River Soil in 1899: For previous records of growths made by these seeds, see tenth annual report, pages 26 and 27, and eleventh annual report, pages 53 to 55. The seeds came up this season in but limited numbers. Examination of the beds made upon June 13th showed the following growths: Seeds of Shepperd's Purse (Capsella) produced forty-seven growths from one and two inch plantings. French weed (Thlaspi) produced fifty-four plants from a depth of one inch of original planting, and thirteen plants from the two-inch planting. Pigeon grass seed (Setaria) showed no growths from any depth. King-head (Ambrosia) gave an interesting number of plants. Twenty-five plants from depth of one inch. One hundred and sixteen plants from depth of two inches. Twenty-nine plants from depth of three inches. Fourteen plants from depth of four inches.

There were no plants from greater depths in this bed.

Wild buckwheat (Polygonum) produced no plants from any depth. Wild oat (Avena Fatua) produced eight plants from depth of two inches, none from other depths.

On date of October 7, 1901, one plant of King-head came up from a depth of three inches and one plant of mustard from a depth of three inches in bed No. 5.

June 14th Germination Tests Were Made Upon These Seeds as Follows: 1. Capsella Bursa pastoris (Shepherd's Purse) seventy-six growths from seeds taken from ten inches deep. Percentage of vitality not determined.

2. Thlaspi arvense (French Weed.) From a very large number of seeds in the mass of dirt taken from seven inches deep, only five growths occurred; fifteen growths occurred from the mass of dirt taken from ten inches deep. The percentage of viability was not determined.

Out of twenty-five seeds taken from a depth of seven inches none grew.

Out of fifty seeds from the mass taken at ten inches deep, two seeds grew equal 4 per cent.

Setaria viridis (pigeon grass) 100 seeds taken from a depth of 7 inches produced 34 plants and 100 seeds from a depth of 10 inches showed a vitality of 20 per cent.

From the mass of dirt (7 inches of the seed bed) from a depth of 5 inches, 382 plants grew.

From a like mass from a depth of 10 inches there grew 198 plants.

Ambrosia trifida (king head). A test of fifty seeds taken from a depth of 7 inches gave an 8 per cent viability.

In the case of 50 seeds taken from 10 inches deep, there was 22 per cent of growths.

Brassica sinapistrum (mustard). Of 100 seeds from a depth of 10 inches, there were 20 per cent of viable seeds.

Of 100 seeds from a depth of 7 inches, there grew 71 plants.

Polygonum convolvulus (wild buckwheat). A test of over 300 seeds taken from a depth of 7 inches and 10 inches found all seeds thoroughly decayed.

Avena fatua (wild oat). Many seeds were taken from a depth of 10 inches. All were decayed.

Notes: The soil upon which these beds are placed lies very low. A depth of one foot was sufficient to reach water at almost any season of the year. The conditions for the survival of the seeds can hardly be thought so good as those usual to regular farm soils. The greatest depth from which a seed put up a plant this year was 5 inches in the case of kinghead, and three inches for a mustard seed.

Miscellaneous Plant Diseases:—As the agricultural soils of the state grow older, it becomes apparent that the parasitic diseases of cultivated plants are brought in with the seeds, and in other ways which are closely associated with the general farm operations. The farmers of this new state should as quickly as possible appreciate this fact. The worst plant diseases are not native to the virgin soils. "Clean and healthy seeds" should be a watchword here. As examples of diseases which have lately been introduced, one may call attention to the potato rot (phytophthora) and asparagus rust. The first named is a most destructive disease, and it would mean much to potato growers to be able to hold it in check. While it may be distributed by the wind, its habits and nature are such that it is more liable to reach a new locality by way of potato tubers used for planting. If the weather is favorable it may then spread rapidly. The asparagus rust first appeared at Fargo and other points in the state in the summer of 1899. Last year the disease was intensely destuctive, killing almost every plant early in August. This disease spreads by way of the wind. At present about the only known way of checking its ability to do harm is to cut and burn all old asparagus brush each autumn. Spraying has been shown to be effective but is a very costly work for this crop; it would, however, pay those who are raising this plant in large quantities for market.

Wheat smut (Tilletia) was very desctructive in fields in which infested but untreated seed wheat was planted.

The experiment upon injured wheat described elsewhere in this report gave an opportunity to take some notes. One interesting

point was that some of the seeds produced quite a high percentage of loose smut, while others were free from the disease. Thus while it is usually considered that this sort of smut is spread through the fields of young growing wheat by way of the wind, the point of attack being at the nodes, there is here given some indication that one of the chief ways of infection is by way of the seed as in the case of stinking smut.

A rust on flax produced a considerable amount of damage this season (See description in Bulletin No. 50).

Correspondence: The correspondence of the department has increased over that of previous years, showing perhaps a wider interest in matters pertaining to plant life. The following summary of letters answered since last report will indicate in a manner the nature of the queries received:

Germination tests of seed grain	601
Letters upon general matters from outside the state	176
Letters upon general matters from inside the state	62
Requests for special Bulletin No. 46	107
Determination of weeds and other plants	68
Insects, worms, etc., attacking plants	26
Grasshoppers	17
Water hemlock	16
Smuts of cereal grains	25
Analysis of diseased animal tissues	5
Plant diseases	5
Examinations of milk and water for bacterial content	7
Total	1,115

Assistance and Equipment: Mr. L. R. Waldron has been on leave of absence from the college since June, 1901. Upon his return in September, the working force of this department of the college and station will be such as to allow more time to be devoted to station work. In the absence of Mr. Waldron, Mr. Thomas Manns, as a student assistant, has given efficient aid in several lines of investigation.

January 1, 1902, finds the department of botany and zoology of the college and botany of the experiment station housed in new quarters especially planned for the work. There are the following rooms:

1. The general biological laboratory 27x45 feet, associated with which are dissection and preparation room, 10x20 feet, and a store and locker room 11x11 feet.
2. The herbarium and botanical laboratory 27x32 feet, with store room 7x10 feet.
3. An office and library room 14x27 feet.
4. The station and bacteriological laboratory room 27x32.

Each of the three large rooms is well lighted upon two sides.

The station laboratory has good hood and a fine glass culture cage. This room is in every way well equipped for its purpose. To further the interest of student and experimental work with plants, there is planned a small green house 20x30 feet, to be connected with the general laboratory by a door leading to the south. This will be large enough to furnish plants for student use, and also a space for exact control of certain experiments in the study of plant diseases and physiology. This green house is very much needed and it is hoped may soon be constructed.

Respectfully submitted.

HENRY L. BOLLEY,

Botanist.

AGRICULTURAL DEPARTMENT.

To Director J. H. Worst:

Sir: In making the twelfth annual report of this department, I desire briefly to recount the lines of investigation which have engaged the attention of its workers during the year and will give a more extended report upon such portions of it as have not been handed to you as bulletins, except such material as is being held for future publication in bulletin form.

The destruction of the combination horse and cattle barn by fire on January 4, 1901, left the department no opportunity to carry on further trials with horses or cattle until about January 1, 1902. New barns were not ready for occupancy until September, and the collection of minor but necessary pieces of apparatus for feeding trials required additional time.

A study in growing and fattening pigs under local conditions has been successfully carried forward and I expect to be able to hand you a detailed report in bulletin form after the trial is carried long enough to be conclusive.

Pasturing trials with sheep which were undertaken during the season were interefered with to some extent by the serious flooding of the station grounds during the season. Important data was secured, however, and I hope to be able to present it in bulletin form together with the unpublished results of trials made in other years, at some future time.

Conducting stock judging tours with animal husbandry students, assisting in farmers' institute meetings and helping to

instruct farmers excursion parties which have visited the station grounds during the past year has occupied about one-fifth of the time which I have had to devote to both the college and station, while my assistant has spent a similar proportion of his time in institute work, in conducting excursion parties and in preparing and placing exhibits.

The answering by correspondence of specific inquiries relative to farm problems has materially increased over that reported for last year, but the clerical aid which you have provided makes correspondence enough more expeditious to offset the increase in its volume.

As heretofore the breeding, testing and manner of seeding studies, with cereal crops has been given a prominent part of the effort expended by the department. Macaroni wheat an emmer or spelt are two of the newer plants brought forward which seem to show special promise for the portions of the state to which they are particularly well adapted.

Among the forage crops, corn, millet, the more promising grasses, clover and alfalfa have received careful study. The breeding work with clover and alfalfa thus far has resulted in a fair degree of progress, but where selection toward hardiness and acclimation are the ends sought progress while valuable and important is of necessity slow.

The bureau of plant industry of the United States department of agriculture has entered into co-operation with this department and furnished red clover seed from fifteen different states and countries for trial. Seed thus provided was sown last spring and is now under careful study.

The department has other stocks of alfalfa and red clover seed which are descended from plants which have proved hardy enough to withstand the conditions of the more trying seasons. The department is constantly upon the alert for valuable introduced things. One of the more promising new things is Turkestan alfalfa described elsewhere in this report. The cultivation methods and soil moisture study has given asl arge returns in valuable dadt for the expenditure of time and money by the department as has any line of experimentation conducted by it. Bulletin No. 48 which consists of a report upon that study has been well received and has taught our people a valuable lesson.

Root studies with wheat have been made during the season at Fargo and at Edgeley and have given interesting results. The rotation trials increase in value as time permits of additional studies. The work with flax whch I inaugurated eight years ago has proven an especially valuable study and of late has engrossed the botanical department in as strong and valuable a study as it has this division. The department has made few changes in the rotation trial plots and has secured good results, as is shown by a recent publication.

The seed exchange trials, which the fire of 1901 interfered with have given rather conclusive results which have tended to check a too common custom of changing seed for change sake.

PLANT BREEDING AND SEED DISTRIBUTION.

During the past season 17,230 individual plants were produced in the plant nursery for breeding and selection.

That number includes 7,430 individual wheat plants, 730 of which are included in a co-operative trial with the chemical department of this station and are from plants which have been analyzed while the seed from the plants grown has also been subjected to chemical analysis in order that a hereditary or breeding study of the chemical constiutents may be made.

Of the other cereals, 15,830 plants were grown which consist of the following: Oats, 2,400 plants; barley, 1,600; flax, 2,000; buckwheat, 1,200 and millet 1,200 plants.

Following is a list cf the forage plants grown in the plant nursery: Eight hundred alfalfa plants, 300 brome grass plants and 300 slender wheat grass individual plants.

The seed from the best plants is saved and increased and passed through the variety trials against other kinds, and those which prove to be superior strains are distributed by sale.

The department has been longest working with wheat and hence is further along with it than with any other plant. The records show that 499 bushels of pedigreed wheat have been distributed by sale in 126 separate lots to as many addresses. It has thus passed into twenty-eight counties in the state. The loss of a large quantity of the increased seed of pedigreed oats, barley and other plants in the fire which destroyed the college barn Jan. 4, 1901, caused a delay of several years in the time of distribution of some of these sorts, as that accident reduced the quantity of seed in some instances from twenty-five bushels to an ounce or less.

The appointment of the writer as a collaborator in the bureau of plant industry of the United States department of agriculture and the appointment of Mr. E. G. Schollander as special agent of that department, to be paid by the United States department of agriculture, to aid in the co-operative work at the station is substantial recogniton of the work accomplshed and now under way. The additional efficient aid thus given has enabled the department to extend and systematize the work. One hundred bushels of choice seed corn representing eight years work in breeding and selection upon the station grounds has been stored and dried by artificial heat, and is now being distributed in suitable districts in the state. The department will also send out a considerable quantity of wheat of good fife and macaroni types, and 100 bushels of a well bred variety of potatoes.

GRAIN AND FORAGE CROP EXHIBITS.

This department has expended considerable time and energy in preparing and placing educational exhibts which were arranged to convey an intelligent idea of the work which this station has done and of the results accomplished in breeding and introducing the above named classes of crops.

A comprehensive exhibit of that character has been maintained in a prominent place in Fargo during the entire year. Exhibits were made at the state fair at Mandan and at the harvest festival or fair at Casselton. An exhibition is also in place at Edgeley which comprises chiefly the representation of trials made upon the Edgeley sub-station grounds during the season of 1901.

This department in conjunction with the horticultural department of the station, furnished a large amount of material for the display of plant products made at the Pan-American exposition held in Buffalo, New York, during the past season.

An exhibit of the stock foods produced by this station was made at the international live stock exposition held in Chicago, November 30th to December 7, 1901, and an arrangement was made for it to be placed upon exhibition in Chicago where it will remain permanently. These exhibits have attracted large attention, have strongly represented the work of the station and have proved attractive and very welcome additions to the exhibitions of which they have constituted a part.

In each case the department has been strongly urged by those in charge to take a similar part in future exhibitions.

I believe this line of endeavor is bringing good returns to the station, and that it should be continued. A. M. Ten Eyck and L. F. Seneco have had charge of the details of this line of work, and the degree of success which the enterprise has secured is an indication of their ability in that direction.

TURKESTAN ALFALFA.

A plat of land two and one-third acres in extent was sown to Turkestan alfalfa on May 21, 1901, at the rate of fifteen pounds per acre. The seed used was purchased from Currie Bros., seedsmen. The seed was sown broadcast upon old land which had been in a timothy and clover meadow for several years. This plat has been broken the fall before; was in good tilth which permitted the seed to be harrowed in reasonably well. On July 2, twelve days after sowing, the young plants stood two inches high, constituting a good stand. Later in the season the plants growing in small groups from two to ten feet across, and irregular in form took on a yellowish hue and failed to grow as rapidly as their neighbors. That condition was probably caused by the water standing upon the spots so affected—shorter or longer periods—during the growing season.

On August 2nd the plat had a fair hay crop upon it, but it was somewhat weedy in places with pigeon grass or fox tail and amaranthus or red root. The alfalfa was twenty to twenty-two inches high except in the yellow groups where the plants had only a height of from six to ten inches. A few of the plants were showing blossoms upon the above date. The effect of the winter season upon this plat is awaited with interest. Promising results are reported for it from a few places in the state where it was planted in the spring of 1900.

VARIETIES OF GRAIN.

WHEAT.

Thirty-eight varieties of wheat were grown in the field trial in 1901. Seventeen of these were varieties of macaroni wheat secured mainly from the United States department of agriculture. The others were chiefly strains of fife and blue stem, which were obtained from the various seedsmen and from the Minnesota experiment station. These varieties were all new seed. The seed of the old varieties was nearly all lost in the fire, which destroyed the station barn in January, 1901. Fortunately small packets of seed of some of the best old varieties and also of several new ones, which this station had bred up and was preparing to propagate in a field way were stored in another building. This grain was sown in small plots last season and enough seed has been secured to continue the field trials in 1902 or 1903.

The land used for the field trial last season grew a crop of corn in 1900 and was not plowed, but the ground was disc pulverized twice (lapped one-half), just before seeding. All of the varieties were sown on April 26th and 27th. The rate of seeding was five and one-half pecks per acre. The wheat was not treated for smut. On May 2nd, just as the wheat was beginning to come up, the field was rolled and harrowed. This left the soil in excellent condition and free from weeds. On July 2nd it was noted that some varieties of wheat were in full head and that nearly all varieties were heading. The wheat had stooled well and the stand was excellent. The very heavy rains of July 4th and 5th damaged the crop and the heads failed to fill well. The fife varieties seem to have been injured the most, while the macaroni types were the least affected by the wet weather. There was little difference in the varieties in the ripening period. Harvesting was begun July 31st and completed August 3rd. The results of the trial are given in table 1.

Table I.—Varieties of Wheat—Crop of 1901.

Bulletin Number	Variety	Class	Where From	Days Maturing	Length of Stem—Inches	Bearded, Smooth, or Velvety Chaff	Length of Heads—Inches	Grain: Grade*	Grain: Hard Wheat—Per Cent	Grain: Weight Per Bu.—Pounds	Grain: Yield Per Acre—Bushels
247	Minnesota, No. 185, Advance	Cross Bred	Minnesota Exp. Station	96	34	Bearded.	2½	2 N.	80	58½	19.7
248	Minnesota, No. 188, Preston	Cross Bred	Minnesota Exp. Station	97	39	Bearded.	2¾	3 N.	80	58¼	25.7
249	Minnesota, No. 149, Selected Powers	Fife	Minnesota Exp. Station	97	36	Smooth..	2½	3 N.	95	57½	22.8
250	Minnesota, No. 155, Selected Glyndon (818)	Fife	Minnesota Exp. Station	97	36	Smooth..	2½	3 N.	95	58	25.3
251	Minnesota, No. 171, Selected Rysting's	Fife	Minnesota Exp. Station	97	39	Smooth..	3	3 N.	95	58	26.0
252	Minnesota. No. 181, Selected McKendry's	Fife	Minnesota Exp. Station	97	38	Smooth..	3	2 N.	95	58½	27.1
253	Saskatchewan	Fife	Northrup, King & Co	97	37	Smooth..	2½	3 N.	90	58¼	27.2
254	Pillsbury	Fife	Northrup, King & Co	97	36	Smooth..	2½	3 N.	90	58	26.9
255	White	Fife	Wm. Rennie, Toronto	97	36	Smooth..	2½	3 N.	85	58	26.2
256	Red Fern	Fife	Wm. Rennie, Toronto	97	37	Smooth..	2¾	3 N.	85	57½	26.5
257	Minnesota, No. 285	Fife	Minnesota Exp. Station	98	41	Smooth..	3	2 N.	95	60	29.9
258	Minnesota, No. 288	Fife	Minnesota Exp. Station	98	39	Smooth..	2⅝	2 N.	95	58	24.9
259	Minnesota, No. 292	Fife	Minnesota Exp. Station	98	38	Smooth..	2⅝	2 N.	80	58½	24.1
260	Minnesota, No. 293	Fife	Minnesota Exp. Station	98	39	Smooth..	2⅝	2 N.	95	58½	25.6
261	Experiment Station, No. 66	Fife	John Davis, Buxton, N. D.	97	38	Smooth..	2½	3 N.	95	57	27.0
262	Haynes' Pedigree	Blue Stem.	L. H. Haynes, Fargo, N. D.	99	40	Velvety..	3	2 N.	95	58	28.1
263	Marvel	Blue Stem.	John A. Salzer Seed Co	99	40	Velvety..	2¾	2 N.	95	58	28.4
264	Haynes'	Blue Stem.	Minnesota Exp. Station	99	40	Velvety..	3	2 N.	96	59¼	29.7
265	Bolton's	Blue Stem.	Minnesota Exp. Station	99	40	Velvety..	3	2 N.	95	59	29.7
266	Selected Haynes'	Blue Stem.	Minnesota Exp. Station	99	40	Velvety..	3	2 N.	95	59½	30.2
267	American	Blue Stem.	Wm. Rennie, Toronto	98	41	Velvety..	3	2 N.	95	59	30.5
268	Aronautka	Macaroni..	I. N. Oium, Lisbon, N. D.	99	42	Velvety..	2¼	2	90	62	34.0
269	Wild Goose	Macaroni..	Wm. Rennie, Toronto	99	42	S. beard.	2	2	90	62	33.1
270	Berdianska, U. S., No. 1586	Macaroni..	Russia, from Marseilles, France, by U. S. Department of Agriculture	95	40	S. beard.	2	2	80	60½	29.6
271	Novorossisk, U. S., 1567	Macaroni..	Russia, from Marseilles, France, by U. S. Department of Agriculture	96	39	S. beard.	2	2	90	61½	33.4
272	Algerian, U. S., No. 1568	Macaroni..	Marseilles, France, by U. S. Department of Agriculture	95	40	S. beard.	2	....	..	....	22.8
273	Argentine, U. S., No. 1740	Macaroni..	Marseilles, France, by U. S. Department of Agriculture	96	40	S. beard.	2	....	..	....	28.4
274	Taganrog, U. S., No. 1570	Macaroni..	Taganrog, Russia, by U. S. Department of Agriculture	95	40	S. beard.	2	3	85	58½	29.8

Table I.—Varieties of Wheat—Crop of 1901.—Continued.

Bulletin Number	Variety	Class	Where From	Days Maturing	Length of Stem—Inches	Bearded, Smooth, or Velvety Chaff	Length of Heads—Inches	Grain: Grade *	Grain: Hard Wheat—Per Cent	Grain: Weight Per Bu.—Pounds	Grain: Yield Per Acre—Bushels
275	Pellissier, U. S., No. 1584	Macaroni..	Algeria, by U. S. Department of Agriculture	94	41	S. beard.	2½	Rej.	..	52½	19.0
276	Medeah, U. S., No. 1381	Macaroni..	Algeria, by U. S. Department of Agriculture	95	40	S. beard.	2	3	65	57	24.9
277	Yellow Gharnovka, U. S., No. 1444	Macaroni .	Ambrocievka, Russia, by U. S. Department of Agriculture	94	40	S. beard.	2	2	80	61¾	30.8
278	Gharnovka, U. S., No. 1443	Macaroni..	Ambrocievka, Russia, by U. S. Department of Agriculture	94	40	S. beard.	2	3	80	60½	31.4
279	Black Don, U. S., No. 1446	Macaroni..	Ambrocievka, Russia, by U. S. Department of Agriculture	94	39	V. beard.	2	3	75	57½	25.9
280	Gharnovka, U. S., No. 1447	Macaroni..	Taganrog, Russia, by U. S. Department of Agriculture	94	40	S. beard.	2	2	85	61	32.4
281	Beloturka, U. S., No. 1520	Macaroni..	Russia, by France, by U. S. Department of Agriculture	94	42	S. beard.	2	2	75	62	32.6
282	Kubanka, U. S., No. 1440	Macaroni..	Uralsk, T. Russia, by U. S. Department of Agriculture	94	40	S. beard.	1¾	2	70	61	32.5
283	Velvet Don, U. S., No. 1445	Macaroni..	Ambrocievka, by U. S. Department of Agriculture	94	41	V. Beard.	2	3	80	60	29.6
284	Polish, U. S., No. 1565	Flint	France, by U. S. Department of Agriculture	98	42	S beard.	4	2	85	57¼	21.9

* Macaroni varieties have no milling grade,

Table II.—Five Varieties of Wheat in Each Class, viz.: Macaroni, Fife and Blue Stem, Giving Largest Yields in 1901.

Bulletin No.	Variety	Class	Grade	Hard Wheat—Per Cent	Weight Per Bu.—Pounds	Yield Per Acre—Bushels
268	Aronautka	Macaroni	2	90	62	34.0
271	Novorossisk	Macaroni	2	90	61½	33.4
269	Wild Goose	Macaroni	2	90	62	33.1
281	Beloturka	Macaroni	2	75	62	32.6
282	Kubanka	Macaroni	2	70	61	32.5
267	American	Blue Stem	2 N	95	59	30.5
266	Selected Haynes'	Blue Stem	2 N	95	59½	30.2
264	Haynes'	Blue Stem	2 N	96	59¼	29.7
265	Bolton's	Blue Stem	2 N	95	59	29.7
263	Marvel	Blue Stem	2 N	95	58	28.4
257	Minnesota, No. 285	Fife	3 N	95	60	29.9
253	Saskatchewan	Fife	2 N	90	58¼	27.2
252	Selected McKendry's	Fife	2 N	95	58½	27.1
261	Experiment Station 66	Fife	3 N	95	57	27.0
254	Pillsbury	Fife	3 N	90	58	26.9

In yielding qualities aronautka macaroni wheat stands at the head in this trial. The seed of this wheat was obtained from T. N. Oium, Lisbon, North Dakota. The wheat has been grown in Ransom county for eight years, and the original seed is said to have been brought from Canada. The variety has been thoroughly acclimated and adapted to North Dakota soil and conditions. Several of the macaroni sorts received from the United States department of agriculture yielded nearly as well as aronautka, and the wild goose wheat from Wm. Rennie, Toronto, Canada, is also an excellent variety of the macaroni type.

In the blue stem class, American blue stem from Wm. Rennie, Toronto, Canada, gave the largest yield, which was closely seconded by Selected Haynes' blue stem, a strain of Haynes' blue stem, which has been bred up by selection at the Minnesota station. The original Haynes' blue stem is still being grown for seed by L. H. Haynes, Fargo, North Dakota. The original seed of Bolton's blue stem came from Thomas Bolton, Park River, North Dakota. This is also an excellent strain of blue stem wheat.

The best producing fife variety, Minnesota No. 285, is one of Professor Hays' selected and improved varieties. It is a coarse, large headed variety, with smooth but slightly bearded chaff, and the grain appears to be of good quality, while the variety is also an excellent producer. As an average for eight years' trials, the yields of the best producing fifes and the best producing blue stems stand as follows:

Blue Stem ....24.9 bushels per acre
Fife ....24.0 bushels per acre

As regards grade, the fife has averaged a little less than one grade better than the blue stem.

Comparing the average yield of the five best producing varieties in each class for the year 1901 gives the following:

Class	Yield Per Acre—Bushels	Difference—Bushels
Macaroni	33.1	
Blue Stem	29.7	3.4
Fife	27.6	5.5
Blue Stem and Fife	28.6	4.5

The macaroni sorts yielded 3.4 bushels per acre more than the blue stem and 5.5 bushels more than the fife, or 4.5 bushels more than the average of the fife and blue stem varieties taken together.

Macaroni wheat has been grown at this station for three seasons. The yields of macaroni as compared with the best producing fife and blue stem varieties for the three crops is given below:

Crop	Yield Per Acre		Difference—Bushels
	Macaroni—Bushels	Fife and Blue Stem—Bushels	
1899	34.9	26.6	8.3
1900	20.5	23.6	-3.1
1901	33.1	28.6	4.5
Average	29.5	26.3	3.2

The macaroni wheat has outyielded the other sorts two years out of the three. In the dry season of 1900, the macaroni wheat made a thrifty growth and filled well, but was thin on ground. The kernels of macaroni wheat are generally larger than those of fife or blue stem, and in order to get an equal number of these larger kernels in the ground, the drill should be opened to sow about a peck more per acre than is ordinarily sown of fife or blue stem. It appears also that macaroni wheat stools less than other wheat, and the experience at this station indicates that it should be sown a little thicker for this reason. If the drill is set to sow one and one-half bushels of wheat per acre, macaroni wheat will scarcely stand too thick, even in the most favorable seasons.

Reports from the S uth Dakota experiment station and from points west of the Red River Valley in North Dakota indicate that a greater difference in yield in favor of the macaroni wheat is to be expected there.

There seems to be ample demand for this wheat by macaroni manufacturing establishments in this country, as they now import large quantities of it. It was purchased at the price of No. 2 Northern wheat during the past season.

The following letter from the Van Dusen Harrington company, of Minneapolis, bearing the date of Nov. 15, 1901, indicates the views of that firm relating to the market demand for macaroni wheat:

Replying to your valued favor of the 14th would state so far we have purchased all of the offerings in this market of the macaroni wheat. The receipts have been very light at the present time on account of the weather and also for the reason that quite a percentage of the present crop is being held for seeding purposes. So far as we are able to ascertain there will be a continued good demand for this wheat.

Yours truly,

(Signed.) THE VAN DUSEN HARRINGTON CO.

A good quality of bread can be made from flour milled from

macaroni wheat, but the fact that bread and flour from macaroni wheat is yellow or dark in color causes it to have much less value upon the general market.

It requires some special skill to grind it also, which causes most millers and elevator firms to refuse to handle it for flour production.

The better strains of macaroni wheat while resembling the wild goose strain differ from it considerably and are less flinty and more like the bread wheats.

AMOUNT OF SEED WHEAT TO SOW.

The experiment of seeding wheat at different thicknesses was continued during season of 1901. The trial was made on fall plowed land, which grew a crop of wheat in 1900 and corn in 1899. Selected Minnesota No. 163 was the seed used in this trial. The plots were seeded May 7th with a Dowagiac shoe-chain drill. The thickness of seeding trials was begun with this drill, and it has been used in all succeeding trials in order that the results from year to year may be comparable.

No regularly marked difference was observed in the time of ripening of the 1901 crop. The thinnest sown wheat showed a good stand. The straw averaged about thirty-six inches in height on all of the plots, and the heads were of good length, but not very well filled. Close observations revealed the fact that the straw was thicker and more inclined to crinkle at the bottom on the thicker sown plots. The grain on all the plots was ripe and harvested August 8th.

Table III gives the results of the trial, and includes the average yield for all trials which have been made at this station.

TABLE III.—AMOUNT OF SEED WHEAT PER ACRE.

Plot Number	Seed Sown Per Acre—Pecks	Crop of 1901					Average for 1898, 1899, 1900 and 1901	Average for Eight Trials
		Stand	Grade	Hard Wheat—Per Cent	Weight Per Bushel—Lbs.	Yield Per Acre—Bushels	Yield Per Acre—Bushels	Yield Per Acre—Bushels
1	3	Good	2 N.	95	59½	18.7		
2	4	Very good	2 N.	95	58¼	20.6	24.0	18.6
3	4½	Very good	2 N.	95	60	21.2	24.0	19.5
4	5	Quite thick	2 N.	95	60	21.4	24.2	19.4
5	5½	Thick	2 N.	95	59	21.6	24.8	20.3
6	6	Thick	2 N.	95	59½	21.0	25.6	19.9
7	7	Very thick	2 N.	95	60½	21.0	25.8	
8	8	Very thick	2 N.	95	59¼	20.0		

As an average for the four trials six and seven pecks of seed wheat per acre have given the largest average yield. This average includes the crop of the dry season of 1900, in which the increased yeld from the thick seeding was very marked. In the 1901 trial and as an average for eight trials, five and one-half pecks of seed has produced the largest yield of wheat.

VARIETIES OF OATS.

Twenty-six varieties of oats were grown in the field trial in 1901. Nearly all of these were new varieties secured from various seedsmen and grown at this station for the first time last season. A few were new seed of some of the old varieties which have been reported upon in Bulletin No. 39, and in the eleventh annual report of this station.

The oats were sown upon fall plowed land which grew wheat in 1900 and corn in 1899. The field was prepared with the Acme harrow and seeded on May 3rd and 4th at the rate of two bushels of oats per acre. The oats came up well, stooled heavily and made a good stand on all the plots. On those plots which gave the largest yields, the stand was noted as being "excellent" and "thick." The oats were not injured much by the wet weather. All varieties were attacked by rust, but not enough to seriously damage the crop. Black oats seem as a rule to rust worse than white ones, and late oats are perhaps more often injured by rust than are early varieties. Varieties which have a medium season are usually least affected by rust and adverse conditions.

Because of the heavy growth of straw the oats lodged some on nearly all of the plots. Nos. 84, 105 and 106 did not lodge. Nos. 85, 95, 100, 103 and 104 lodged 10 to 20 per cent. Nos. 99 and 101 lodged 60 per cent. No. 86 lodged 50 per cent, and the other varieties were noted as being lodged from 30 to 40 per cent. No. 80 (sixty day oats) was harvested July 22nd, eighty days after planting. The regular harvest began July 31st and was completed August 10th. The oats were thrashed in good condition from the shock during the last week in August. Table IV gives the results of the trial.

Table IV.—Varieties of Oats—Crop of 1901.

Bulletin Number	Variety	Where From	Days Maturing	Length of Straw—Inches	Form of Heads	Length of Heads—Inches	Color of Berry	Size of Berry	Shape of Berry	Weight Per Bushel Pounds	Yield Per Acre—Bushels
81	Racehorse	*Missouri Exp. Station	96	45	Side	11	White	Medium	Medium long	34	43.3
82	American White Banner	*Missouri Exp. Station	91	41	Wh'l'd	9½	White	Medium large	Medium long	34	55.2
83	Tartarian	*Missouri Exp. Station	98	44	Side	11	White	Medium large	Medium long	34¼	43.9
84	Sixty Day, U. S., No. 5938	Russia, by U. S. Department of Agriculture	80	32	Wh'l'd	5½	Yellow	Medium small	Slender	32	50.4
85	Silver Mine	John A. Salzer Seed Co.	91	40	Wh'l'd	7	White	Medium large	Medium	36¼	60.9
86	White Bonanza	John A. Salzer Seed Co.	90	42	Wh'l'd	8	White	Medium	Short and plump	36¾	57.0
87	Big Four	John A. Salzer Seed Co.	89	40	Wh'l'd	7	Yellowish	Medium	Medium short	37½	58.8
88	Great Northern	John A. Salzer Seed Co.	90	43	Wh'l'd	9	White	Medium large	Medium long	36	56.0
89	Bow of Promise	John A. Salzer Seed Co.	89	42	Wh'l'd	8	White	Medium	Short	36	60.3
90	Bucktu's Illinois	H. W. Bucktu, Rockford, Ill.	95	50	Side	9	White	Medium large	Medium long	34	45.5
91	Quaker	H. W. Bucktu, Rockford, Ill.	93	48	Side	10	White	Medium large	Medium long	34¼	48.5
92	Sunol	H. W. Bucktu, Rockford, Ill.	93	46	Side	10	White	Medium large	Medium long	31	45.0
93	Lincoln	Oscar H. Will & Co.	92	43	Wh'l'd	8	White	Medium large	Medium long	35½	57.5
94	Minnesota, No. 26, Early Gothland	Minnesota Exp. Station	90	41	Wh'l'd	8½	White	Medium	Medium long	35½	60.5
95	Minnesota No. 6, Imp. Ligowa	Minnesota Exp. Station	89	40	Wh'l'd	7	White	Medium	Short	36½	54.9
96	Minnesota, No. 32, White Wonder	Minnesota Exp. Station	90	42	Wh'l'd	10	Yellowish	Medium	Medium	32½	59.4
97	Minnesota, No. 103	Minnesota Exp. Station	91	42	Wh'l'd	10	White	Medium small	Short and slender	35¾	59.4
98	Minnesota No. 202	Minnesota Exp. Station	92	45	Wh'l'd	10	Light yellow	Medium small	Short and slender	35½	67.1
99	Moli's New Black Beauty	Northrup, King & Co.	95	44	Side	9	Brown	Medium	Medium	29	42.2
100	Siberian White	Wm. Rennie, Toronto	90	42	Wh'l'd	9	White	Medium large	Medium long	37¾	60.5
101	Black Tartarian	Wm. Rennie, Toronto	94	52	Side	10	Brown	Medium large	Long	28	39.8
102	Abundance	Wm. Rennie, Toronto	91	44	Wh'l'd	9	White	Medium large	Medium long	35	59.0
103	Ligowa	Wm. Rennie, Toronto	90	41	Wh'l'd	7	White	Medium	Short and plump	38	58.4
104	New Zealand	Wm. Rennie, Toronto	97	50	Side	9	White	Medium large	Short	37½	49.9
105	New Danish White	Wm. Rennie, Toronto	90	38	Wh'l'd	8	White	Large	Medium long	37¼	54.0
106	Egyptian	Wm. Rennie, Toronto	91	39	Side	7	White	Medium small	Short and plump	37½	50.9

* The original seed of these varieties was grown at the North Dakota station.

TABLE V.—VARIETIES OF OATS GIVING LARGEST YIELDS IN 1901.

Bulletin Number	Variety	Yield Per Acre—Bushels	Weight Per Bushel—Pounds	Harvest Season
98	Minnesota, No. 202	67.1	35½	Medium
85	Silver Mine	60.9	36¼	Medium
94	Early Gothland	60.5	35½	Medium early
100	Siberian White	60.5	37¾	Medium early
89	Bow of Promise	60.3	36	Medium early
96	White Wonder	59.4	32½	Medium early
97	Minnesota, No. 103	59.4	35¾	Medium
102	Abundance	59.0	35	Medium
87	Big Four	58.8	37½	Medium early
103	Ligowa	58.4	38	Medium early
93	Lincoln	57.5	35½	Medium
86	White Bonanza	57.0	36¾	Medium early
88	Great Northern	56.0	36	Medium early
82	American White Banner	55.2	34	Medium

The harvest season of the varieties mentioned in the above table is denoted as "medium" and "medium early." As a matter of fact, there was not more than three days difference in the ripening periods of any of the varieties named. Only one very early variety (No. 84), was grown in the trial last season. The late maturing sorts did not yield well, and are not included in the list of varieties giving largest yields. In the dry season of 1900, the "late" and "medum late" varieties outyielded the earlier sorts.

No. 98, whch gave the largest yield in the 1901 trial is one of Professor Hays' selected varieties and was grown at this station for the first time last season. Silver Mine oats which gave the next highest yield has been tested at this station for three successive seasons, 1899, 1900 and 1901. In 1899 this variety stood at the head of the list in yielding qualities, but in the dry season of 1900, it fell below some of the varieties in its own class. Early Gothland has been tested at this station for several seasons and has proved to be one of the best yielding varieties. It is also excellent in appearance and quality of grain. Siberian White and Bow of Promise appear to be excellent yielders, and the grain of each is extra fine in appearance and quality.

VARIETIES OF BARLEY.

Fifteen varieties of barley were tested in the field trial in 1901. The ground upon which the trial was made had been farmed in the same manner and was prepared as already described for varieties of oats. All the plots were seeded May 4th at the rate of two bushels of grain per acre. The early growth was excellent and the yield proved to be very good except for the late maturing sorts. These made a poor and irregular growth of straw and did not head or fill well, and they did not ripen naturally. The

medium early sorts made an excellent stand and an even growth with large well filled heads. All varieties showed a trace of rust, but not enough to do much harm. Harvest began July 18th and was finished August 2nd. The grain was thrashed from the shock August 3rd.

Table VI gives the data secured in this trial.

Table VI.—Varieties of Barley—Crop of 1901.

Bulletin No.	Variety	Where From	Days Maturing	Length of Straw —Inches	Length of Head —Inches	No. of Rows Per Head	Length of Beards —Inches	Size of Berry	Color of Berry	Weight Per Bu.—Pounds	Yield Per Acre—Bushels
43	Moravian, U. S. No. 5793	Hungary, by U. S. Dept. of Agriculture.......	78	31	3	2	4	Medium large	Bronze.......	46	34.1
44	Silver King............	Salzer Seed Co..	77	33	2¾	6	3½	Medium	Yellow.......	46	38.3
45	Great Beardless....... .	Salzer Seed Co........	77	34	2¼	6	...	Medium large	Yellow.......	44½	34.4
46	White Hulless..........	Salzer Seed Co........	77	28	2	6	...	Medium	Brown.......	56	21.2
47	Minnesota, No. 6, Mansury.................	Minnesota Exp. Station	78	36	3	6	3	Medium large	Yellow.......	46	42.1
48	Minnesota, No. 32.......	Minnesota Exp. Station	78	36	3	6	3	Medium large	Yellow.......	46½	40.0
49	Minnesota, No. 28, Barnard's...............	Minnesota Exp. Station	77	31	2¾	6	4	Medium	Yellow.......	48	37.6
50	Minnesota, No. 87.......	Minnesota Exp. Station	77	37	3	6	3	Medium	Yellow.......	46¾	40.4
51	Minnesota, No. 100, Houston's Golden Queen...	Minnesota Exp. Station	75	30	2⅛	6	4½	Medium	White.......	46	30.6
52	Minnesota, No. 105......	Minnesota Exp. Station	77	33	2⅞	6	3½	Medium	Yellow.......	46	40.3
53	Highland Chief	Northrup, King & Co..	88	30	3 to 4	2	5	Large........	Bronze	49	25.3
54	New White Hulless.....	Northrup, King & Co..	75	24	2⅛	6	..	Medium	Brown.......	57½	22.3
55	Mandscheuri, six-rowed.	Wm. Rennie, Toronto..	78	34	3	6	3½	Medium large	Yellow.......	45	45.1
19	Success	Minnesota Exp. Station	90	26	3½	2	4	Large	Light yellow.	47¾	34.8
21	McEwan's Hulless......	Park River, N. D.......	75	20	3	2	5	Very large...	Brown.......	56½	32.9

TABLE VII.—VARIETIES OF BARLEY GIVING LARGEST YIELDS IN 1901.

Bulletin Number	Variety	Weight Per Bushel—Pounds	Yield Per Acre—Bushels	Harvest Season
55......	Mandscheuri	45	45.1	.Medium early
47......	Mansury ....,...........	46	42.1	.Medium early
50......	Minnesota, No. 87............	46.75	40.4	.Medium early
52......	Minnesota No. 105...........	46	40.3	.Medium early
48......	Minnesota No. 32............	46.5	40.0	.Medium early
44......	Silver King..................	46	38.3	.Medium early
49......	Bernard's....................	48	37.6	.Medium early

In the dry season of 1900, the late maturing varieties of oats and barley yielded much better than the early varieties. In 1901 the late maturing sorts did not yield so well as those which ripened medium early. No. 98 oats (see table IV), which has a medium ripening season gave the largest yield procured in 1901, 67.1 bushels per acre, while Mandscheuri barley, which produced the largest yield of that grain, matures medium early. The results of eight years' trials at this station indicate that with both oats and barley, the varieties which have a "medium" season inclining perhaps to "medium early," have given the largest average yields.

Mandscheuri and Mansury barley mentioned above are doubtless the same variety. The name is spelled differently but pronounced the same in each case and the varieties are alike in every respect. In eight years' trials at this station the Mansury six-rowed barley has proven to be one of the best producing sorts.

*EMMER.

Only two varieties of emmer were grown at this station in 1901. The ground had the same preparation as for varieties of barley. The drill was set to sow two and one-half bushels of barley per acre. At this rate it sowed about two bushels of emmer. In the wet season of 1901 this proved to be thick enough. Usually, however, nine to ten pecks of seed per acre would not be too much. The grain was sown May 4th, came up well and made a good stand. The straw reached a height of thirty-eight inches and carried heads two inches long and well filled. The crop from the home grown seed was ripe August 2nd, ninety days after planting. The United States variety ripened a day later. The grain

* This grain is commonly but erroneously called spelt, and is so called in previous publications by this station.

was thrashed from the shock August 23rd. The tabular statement below gives the yield and weight per bushel.

Variety	Yield Per Acre	Weight Per Bushel
Bulletin No. 2, Dakota grown seed	48.7	38½
Bulletin No. 5, seed from U. S. Dept. of Agriculture.....	56.0	37¼

The above yield is calculated on the basis of forty-eight pounds per bushel. Section 1722 of the laws of North Dakota, as revised by the seventh legislative assembly gives the legal weight of a bushel of spelt as forty-eight pounds.

In the report given above the United States department of agriculture seed gave the greater yield of grain per acre, although the weight per bushel was somewhat less. In former publications by this station, emmer has been discussed under the name of "spelt." It is also commonly called "speltz" or "spiltz." It seems, however, that this is not a true spelt, (Triticum spelta), but that it is botanically known as Triticum dicoccum, the common name of which is emmer, a word of German origin.

Emmer has been cultivated in this country at intervals, locally and experimentally, for a good many years.

Trials were made, according to Wallace's Farmer, about twelve years ago in growing and feeding emmer in Canada. It was later generally discarded as not being the equal of barley and oats for feeding purposes. The special attention given this cereal in recent years is du^ to its introduction into the Dakotas from Russia, by the German-Russian farmers, and to the fact that the United States department of agriculture has introduced and distributed among the experiment stations and throughout the northwest, some of the best Russian seed.

Emmer is grown in Servia, Germany, Russia, Spain and Abyssinia, and to some extent in France and Italy. Russia produces 16,000,000 bushels annually. All the best seed is obtained from that country and when grown in the northwest, it yields a grain equal in quality to that of the original seed. The grain is said to have been introduced into this state by Russian settlers living in McIntosh county. The station first secured seed from Mr. Geo. A. Welsh, Bismarck, N. D., in 1897.

The season of 1897 was very unfavorable on account of heavy rains and flooding of the plots. Under these adverse conditions, emmer yielded 934 pounds per acre, about 29.2 bushels at the rate of thirty-two pounds per bushel, while barley, which grew on an adjacent plot, made a complete failure.

The yield of emmer as compared with barley, oats and wheat

in a four years trial at this station (1898-1901 inclusive) is shown in the following table:

Kind of Grain	Yield Per Acre				
	1898—Pounds	1899—Pounds	1900—Pounds	1901—Pounds	Average—Pounds
Emmer	2,338	2,291	980	2,516	2,031
Barley	2,326	2,360	844	1,946	1,869
Oats	2,400	2,436	1,058	1,933	1,957
Wheat	2,212	1,552	1,397	1,719	1,720

In the above comparison, the average yield of the best producing varieties of wheat, oats and barley and the yield secured from the best producing emmer are compared. The weights are those taken as the grain came from the separator. It will be seen from this table that Emmer has outyielded wheat each season, barley every season but one, and oats two seasons out of the four. As an average for the four trials, emmer has yielded 311 pounds per acre more than wheat, 162 pounds more than barley and 78 pounds more than oats.

The general report of farmers throughout the state, who have grown emmer, is that it is a heavy yielder and very resistent to drouth. At the South Dakota station, and throughout that state, there are favorable reports as to the yielding qualities of this grain compared to barley and oats.

The grain as it is thrashed weighs from thirty-eight to forty pounds per bushel, or about the same as good oats. Botanically, emmer is closely related to wheat. The heads are two-rowed and bearded. The spikelets contain two grains each. The husk or chaff usually adheres to the kernels in thrashing, but when the hulls are removed, the grain very much resembles certain types of Goose wheat, and has the same hard flinty character. By actual trial at this station, it was found that by freight about 20 per cent of the unhulled emmer was chaff, and 80 per cent grain.

Feeding Value. In Bulletin No. 39 of this station, Professor E. F. Ladd reports the results of a chemical analysis of emmer as follows:

Constituents	Emmer Not Hulled—Per Cent	Hulled Grain—Per Cent	Hulls Alone—Per Cent
Water	8.88	10.03	4.62
Ash	4.33	1.84	13.58
Fat	2.55	2.80	1.64
Protein	9.81	11.69	2.81
Crude fiber	10.09	2.94	36.68
Carbohydrates	64.34	70.70	40.67
Totals	100.00	100.00	100.00

The small amount of protein or muscle forming material and the high percentage of ash and crude fiber in the hulls indicate that their actual food value is small. As a coarse food to dilute the rich grain and cause it to be better masticated and digested by stock, the hulls are doubtless of much value. The composition of emmer both hulled and unrulled is compared with that of wheat, oats and barley in the following table:

Constituents	Emmer Whole—Per Cent	Barley—Per Cent	Oats—Per Cent	Wheat—Per Cent	Hulled Emmer—Per Cent
Water	8.88	10.9	11.0	10.5	10.03
Ash	4.33	2.4	3.0	1.8	1.84
Fat	2.55	1.8	5.0	2.1	2.80
Protein	9.81	12.4	11.8	11.9	11.69
Crude fiber	10.09	2.7	9.5	1.8	2.94
Carbohydrates	64.34	69.8	59.7	71.9	70.70
Totals	100.00	100.00	100.00	100.00	100.00

This comparison shows that hulled emmer is very similar in composition to wheat. The percentage of digestible nutrients has not yet been determined, but the composition of the unhulled emmer, which is the natural condition of the grain, indicates that its feeding value should be a little less than that of barley or oats.

No extended trials in feeding emmer have been conducted at this station. The grain has been fed whole to horses, sheep and hogs, usually mixed with, or alternating with other grain. The stock do not seem to eat it with a relish when fed in this way.

The South Dokota station in Bulletin No. 71 reports the results of a feeding trial in which emmer and barley were fed whole, each as a single grain ration, to fattening sheep. During a period of fifteen weeks, the lot of sheep fed barley gained one and one-half times as much as the lot fed emmer. It took 7.47 pounds of Emmer to produce a pound of gain, and 5.09 pounds of barley. The lot of twelve sheep fed emmer consumed 2,244 pounds of that grain in the fifteen weeks, while the other lot of twelve sheep consumed 2,318 pounds of barley.

It was concluded from this experiment that emmer is worth about two-thirds as much as barley for feeding to fattening lambs, as a single grain ration, and that about twice the profit can be realized from fatttening sheep upon barley as can be obtained from feeding Emmer. The results obtained in this experiment apply to these grains only when fed as a single grain ration and fed whole, and should not be used without modification in determining the value of them when used as a part of the ration, to-

gether with other grains. Emmer should not be condemned as a feed until it has been thoroughly tested. Extensive trials have proven that the grain is a good producer. It seems especially adapted to the drier portions of the state. It is very hardy and resists the attacks of rust and smut much better than the common cereals. It is easy to cultivate, requiring about the same methods of culture as are used in growing barley and oats. Emmer should be drilled at about the same rate per acre as oats, and sown early, preferably upon fall plowed land.

FLAX EXPERIMENTS.

No regular variety test of flax was made in 1901. A sample of Argentine flax (seed secured from Magill & Co., Fargo) was sown along side of common flax, both on old land and upon timothy sod. The Argentine flax was thinner, more weedy and did not make so good a growth as the common flax. The actual comparative yields were not determined, but it was estimated that the common flax was at least one-fourth better crop than the Argentine flax.

Quantity of Flax to Sow. The experiment in sowing flax at different thicknesses was continued in 1901. The ground used for the trial produced a crop of millet in 1900, was fall plowed and kept cultivated in the spring until the flax was seeded, May 18th. The flax came up well and made a good stand on all plots and was not weedy. The flax was harvested August 17th. There was little difference in the ripening period. The flax did not ripen evenly, however, and there were many green bolls when it was cut, which injured the quality of the seed.

Table IX gives the data secured and represents the average yields for two crops, 1900 and 1901.

MILLET.

The trial of varieties of millet was a partial failure last season due to deep planting and to adverse weather conditions. At the time of seeding, June 3rd, the surface soil (fall plowing) was quite dry and loose and the seed was sown two to three inches deep. Almost immediately heavy rains fell, the soil became wet and compact, and the millet failed to come up well. Several of the plots contained so little millet and so much pigeon grass that they were discarded from the trial. The varieties which made such a poor stand that they were thrown out of the trial were as follows:

Common millet, German millet (southern grown seed), and Early Fortune millet, from Northrup, King & Co., Earliest Russian millet, from the Salzer Seed Co., and Broom-corn millet, from U. S. department of agriculture.

All of the varieties named in table VIII matured and were cut for seed except Buckbee's California millet, which failed to ripen seed, and was cut for hay September 16th two days before frost.

Table VIII.—Varieties of Millet—Crop of 1901.

Bulletin Number	Variety	Where From	Days Maturing	Height of Straw—Inches	Kinds of Heads	Color of Seed	Size of Seed	Weight Per Bushel—Pounds	Yield of Seed Per Acre—Bushels*	Yield of Straw Per Acre—Pounds	Total Yield Per Acre—Pounds
21	Japanese barnyard grass	U. S. Dept. of Agriculture.	93	33	Cock'sfoot. .	Light brown..	Large...	37¼	58.4	6,572	10,076
22	New Japanese..........	Northrup, King & Co......	93	36	Cock'sfoot ..	Light brown..	Large...	38.0	47.0	6,589	9,409
24	New Siberian..........	Oscar H. Will & Co........	90	32	Foxtail......	Yellowish red.	Medium	55½	39.3	4,773	7,131
25	Bucktu's California....	H. W. Bucktu, Rockford, Ill.	..	40	Foxtail.....	Bright yellow.	Medium	....	....	9,766	9,766
26	Hungarian	Northrup, King & Co......	91	34	Foxtail	Bl'k and green	Medium	50¾	34.4	5,433	7,497
27	Siberian..............	Northrup, King & Co......	91	34	Foxtail......	Yellowish red.	Medium	52½	36.0	5,488	7,648
28	Hog..................	Northrup, King & Co......	90	38	Close broom	Yellow.......	Large..	58½	29.4	3,480	5,244

*Calculated at the rate of 50 pounds per bushel.

In the above trial the yields were somewhat in proportion to the stand of millet on the several plots. Japanese Barnyard Grass and New Japanese millet, which are botanically the same, viz.: Panicum crus-galli, made a very thick stand, in fact too thick for the best growth and production of seed. This grass is classed with the millets in the above trial, but it has no relation to them botanically. It belongs to the same chemical family and looks very much like the common barnyard grass of our fields, however, it appears to be a heavy yielder, both of fodder and of seed. No. 21 in the above trial yields fifty-eight bushels of seed (fifty pounds per bushel), and three and one-half tons of straw per acre. The Salzer Seed company sends this grass out under the name of "Billion Dollar Grass." A small plot of this grass (one one-hundredth of an acre) was seeded in our grass nursery in 1901, early in the season (April 26th.) It made an immense growth and when cut (August 27th) it averaged four and one-half feet in height with heads five and one-half inches long, heavily loaded with seed. The yield from this small plot was at the rate of 3,190 pounds of seed and five and one-half tons of straw per acre.

Japanese Barnyard Grass has not been tested at this station as to its feeding qualities. The fodder inclines to be coarse, but is quite leafy and stock seem to eat it fairly well. The seed is much lighter than millet seed and resembles the wild type in form and color. No experiments have been made as to its feeding value, but the large yield secured would make the crop a profitable one if the seed proves to be valuable for feeding purposes.

Buckbee's California millet which produced the largest yield of fodder, nearly five tons per acre, appears to be a strain of German millet, and made a growth similar to that obtained from southern grown seed. This variety made an excellent stand and a rank growth of fodder, but did not mature seed.

In the eleventh annual report of this station, page 78, a comparison is made of the yields of German millet from southern grown seed and North Dakota seed. As an average for two crops, 1899 and 1900, the North Dakota seed gave one and one-half tons less fodder, but over a ton more grain per acre than the southern grown seed. The total product per acre was as follows:

North Dakota seed ....7,544 pounds
Southern grown seed ....8,555 pounds

It was observed that the millet from southern grown seed made a heavy growth of fodder, but produced few heads and was not inclined to mature seed in this latitude. As millet becomes acclimated here it tends to mature earlier and to produce large quantities of seed.

The yield of millet seed as compared with the yield of other

grains in a three year's trial at this station (1899-1901 inclusive) is shown in the following table:

Kind of Grain	Yield Per Acre			
	1899—Pounds	1900—Pounds	1901—Pounds	Average—Pounds
Millet	2,245	2,095	1,820	2,053
*Emmer	2,291	980	2,516	1,929
Oats	2,436	1,058	1,933	1,809
Barley	2,360	844	1,946	1,717
Wheat	1,552	1,397	1,719	1,556

*This grain is commonly but erroneously called spelt.

In the above comparison the average yield of the best producing varieties in each class are compared. It will be seen from this table that millet has outyielded each of the other grains as an average for the three trials. No particular attention has been paid to the selection of varieties of millet for the purpose of seed production. From ordinary North Dakota grown seed of the German and Hog millet types, yields of forty to fifty bushels per acre are not uncommon. With the Russian Broom-corn types which are now being introduced even larger yields of seed may be secured. (See eleventh annual report of this station, page 79.)

Not only is millet very productive as a crop, but experiments have shown it to be practically equal to corn and potatoes as a rotation crop for wheat. In an eight year's trial at this station, a crop of millet every fourth year gave an average increase of five and one-third bushels per acre in the succeeding wheat crops, as compared with growing wheat continuously.

Feeding Value. No feeding trials with millet seed have been completed at this station. Several trials are contemplated and others are now under way.

Several persons in this state have reported good results from feeding millet seed meal to horses and hogs. In Feeds and Feeding, Professor Henry writes: "Millet is grown in South Europe, parts of Asia and in Africa for human as well as for animal food." In his Feeding Animals, Stewart writes: "Millet meal is a highly appropriate food for young and mature horses. It has a higher proportion of albumenoids and a higher nutritive ratio than oats, but has less oil. It is found, when well ground, (and it cannot properly be fed without grinding), to be one of the best rations for horses, being particularly adapted to the development of muscular strength."

The following table gives the quantities of digestible matter of different kinds in millet as compared with the standard feeding

grains, viz.: corn, barley and oats as given by Professor Henry in his Feeds and Feeding:

NUMBER OF POUNDS OF DIGESTIBLE MATTER IN 100 POUNDS.

Name of Feed	Dry Matter—Pounds	Digestible Nutriments in 100 Pounds		
		Protein—Pounds	Carbohydrates—Pounds	Ether Extracts—Pounds
Corn	89.1	7.9	66.7	4.3
Barley	89.1	8.7	65.6	1.6
Oats	89.0	9.2	47.3	4.2
Millet seed	86.0	8.9	45.0	3.2

The above table indicates that millet resembles oats more closely in the amount and proportion of digestible material which it contains than it does barley or corn. It contains three and three-fifths pounds less total digestible matter per hundred pounds than oats, but while it has less total digestible protein or muscle forming material, it has a larger proportion of it or a narrower nutritive ratio.

The above data and testimony certainly warrant the belief that millet seed is a reasonably sure source of available grain food if intelligently used.

Millet seed meal forms a rather heavy or concentrated food and would be more safely fed if mixed with some coarser material like wheat bran.

Table IX.—Seed Flax—Different Amounts of Seed Per Acre—Crop of 1900

Plot Number	Seed Per Acre—P'cks	Stand	Days Maturing	Height of Straw—Inches	Weight Per Bushel—Pounds	Quality of Seed—Per Cent	Yield Per Acre: Grain—Bushels	Yield Per Acre: Straw—Pounds	Average of Two Crops—1900 and 1901, Yield Per Acre: Grain—Bushels	Average of Two Crops—1900 and 1901, Yield Per Acre: Straw—Pounds
1	1½	Good	91	27	52½	85	11.9	3,227	12.4	2,425
2	2	Good	91	27	53¼	93	11.3	2,840	12.0	2,061
3	3	Excellent	91	27	53¼	92	11.8	2,701	11.0	1,955
4	4	Thick	90	26	53	90	10.5	2,580	12.1	1,971
5	5	Very thick	90	26	55	97	11.0	2,580	13.9	2,161
6	6	Very thick	91	24	52¼	90	10.7	2,420	13.1	1,882

In 1901, the thinnest seeding (one and one-half pecks per acre) produced the largest crop, both of seed and straw. The average yield from the two crops seems also on the whole to be in favor of thin seeding. The thick seeding has given the larger crop of seed as an average for the two trials, but this is due mainly to the large crop secured from the thick seeding in the dry season of 1900, when flax came up poorly and did not branch well.

FLAX AND WHEAT MIXED.

This is the fourth season that experiments have been made by this station in sowing flax and wheat together. The results of former trials are given in the eleventh annual report, page 82. The conclusion at that time was that on ordinary farm land which is only fertile enough to produce one good crop of wheat or flax in a season, nothing is gained by attempting to produce two crops on the same ground at the same time. However, it was observed that on very rich soil where wheat is likely to grow too rank and to lodge, the two grains may be profitably grown together, the flax tending to reduce the growth of wheat and also acting as a support to prevent the grain from lodging. The trial in 1901 was a demonstration of this observation.

The 1901 trial was made upon corn land which was in excellent condition to produce a large crop of wheat. The season proved to be too wet and the wheat went largely to straw, but was less injured upon the plots upon which flax was sown with the wheat than it was where wheat was grown alone. In the 1901 experiment the wheat was sown at the rate of three and four pecks per acre, and the flax at the rate of one and one-half, two and two and one-half pecks per acre. The flax was sown three different dates, viz.: with the wheat, one week after the wheat was sown and two weeks after the wheat was sown. The wheat was drilled east and west and the flax north and south. The plan of the experiment together with the data obtained are shown in Table X.

TABLE X.—FLAX AND WHEAT—CROP OF 1901—SHOWING PLAN OF EXPERIMENTS AND RESULTS.

Plot Number	Crop	Date Sown	Rate Per Acre—Pecks	Date Ripe	Stand	Height of Straw—Inches	Yield Per Acre—Bushels	Weight Per Bu.—Pounds
1	Wheat	May 3	3	August 8	Good	37½	18.83	61½
	Flax	May 3	1½	August 8	35 P. C.	....	.95	52
2	Wheat	May 3	3	August 8	Good	37½	18.00	60
	Flax	May 3	2	August 8	30 P. C.	....	1.61	53
3	Wheat	May 3	3	August 8	Good	38½	17.35	60½
	Flax	May 3	2½	August 8	30 P. C.	....	1.80	52½
4	Wheat	May 3	3	August 8	Good	36½	16.53	60½
	Flax	May 11	1½	August 8	Slight	....	.52	
5	Wheat	May 3	3	August 8	Good	36½	15.60	60½
	Flax	May 11	2	August 8	Slight	....	.57	
6	Wheat	May 3	3	August 8	Good	38½	16.48	60
	Flax	May 11	2½	August 8	Slight	...	.71	
7	Wheat	May 3	3	August 8	Good	37½	10.42	59½
	Flax	May 18	1½	August 8	Trace	....	.89	51¾
8	Wheat	May 3	3	August 8	Good	35	11.35	59½
	Flax	May 18	2	August 8	Trace	....	.22	
9	Wheat	May 3	3	August 8	Good	36	12.89	59½
	Flax	May 18	2½	August 8	Trace	....	.28	
10	Wheat	May 3	4	August 8	Good	38	17.08	60¼
	Flax	May 3	1½	August 8	Slight	....	.76	51
11	Wheat	May 3	4	August 8	Good	38	17.64	61
	Flax	May 3	2	August 8	Slight	....	1.06	
12	Wheat	May 3	4	August 8	Good	39½	16.03	60½
	Flax	May 3	2½	August 8	Slight	...	.95	50¾
13	Wheat	May 3	4	August 8	Good	38	15.47	59½
	Flax	May 11	1½	August 8	Trace	....	.43	
14	Wheat	May 3	4	August 8	Good	30½	15.62	60½
	Flax	May 11	2	August 8	Trace	....	.47	
15	Wheat	May 3	4	August 8	Good	38	14.32	59½
	Flax	May 11	2½	August 8	Trace	....	.38	
16	Wheat	May 3	4	August 8	Good	38½	12.23	59
	Flax	May 18	1½	August 8	Trace	....	.52	
17	Wheat	May 3	4	August 8	Good	38	11.92	59½
	Flax	May 18	2	August 8	Trace	....	.38	
18	Wheat	May 3	4	August 8	Good	39	11.35	59
	Flax	May 18	2½	August 8	Trace	....	.33	
19	Wheat	May 3	4	August 8	Good	37½	10.37	57½
20	Wheat	May 3	4	August 8	Good	36½	11.03	58½

Plots 19 and 20 are the check plots upon which wheat was seeded alone. Plot 20 received no cultivation after seeding, and should be used as a check on plots 1, 2, 3, 4, 5, 6, 10, 11, 12, 13, 14, and 15. It will be noticed that the yield was less from the check plot than from any of the others with which it is compared.

Upon the date that plots 7, 8, 9, 16, 17 and 18 were seeded to flax the wheat was up and in order to have a check upon the effect of the cultivation upon these plots, plot 19 was cultivated in like manner by passing the drill over it without seeding any flax. There is not much difference in the yield of wheat between these several plots, but the check has given the smallest yield. The yield from plot 19, which received the cultivation after the wheat was up was also a little less than that from plot 20 which received no cultivation. The largest yield of wheat alone (18.8

bushels per acre) was obtained from plot 1 upon which wheat and flax were seeded at the same date, at the rate of three pecks of wheat and one and one-half pecks of flax per acre. The largest combined yield (18 bushels of wheat and 1.6 bushels of flax per acre) was obtained from plot 2, which was seeded at the rate of three pecks of wheat and two pecks of flax per acre, on the same date.

It will be observed that the largest yields of both wheat and flax were obtained from the plots which were seeded to both grains on the same date. Where flax was seeded a week after the wheat, the yield of wheat was slightly decreased and the flax yield was very small. Where the flax was sown two weeks after the wheat, there was a large decrease in the wheat yield averaging about six bushels per acre, and the flax crop was practically nothing. The results may be summarized and grouped as follows:

Method	Yield Per Acre	
	Wheat—Bushels	Flax—Bushels
Wheat and flax sown at same date	17.5	1.22
Flax sown one week after wheat	15.7	.51
Flax sown two weeks after wheat	11.7	.43
Wheat alone, not cultivated after sowing	11.0	
Wheat alone, cultivated after sowing	10.4	

Flax sown at the same date with the wheat has caused a direct increase of six and one-half bushels of wheat per acre over wheat sown alone, and has given besides one and two-tenths bushels of flax per acre. The later sowings of flax show a decrease in the flax yield and a very marked decrease in the yield of wheat. This was not the result of injury to the wheat by cultivation, as the small difference in the yields of the two check plots shows. The large difference in yield of wheat seems to be due almost entirely to the better growth of the flax on the early sown plots. The flax helped to use the surplus moisture and retarded the growth of the wheat, causing it to fill better.

The wheat from the check plots weighed fifty-eight pounds to the bushel. That from the plots where flax and wheat were grown together had an average weight of sixty pounds per bushel. Most of the wheat from the plots upon which flax was sown was given a "line" grade of No. 3 northern by Mr. J. W. Carroll of the Fargo Roller Mills.

The wheat from the check plots graded No. 3 northern straight. The weight per bushel of the wheat grown with the flax was sufficient to cause it to grade No. 1 hard. Its appearance, however, in the opinion of Mr. Carroll, would not warrant a better grade

than the one given. The grain was somewhat shrunken and contained many blighted and discolored kernels. All of the flax seed was of good quality—better than that grown alone on adjacent plots.

In the 1901 trial, the best crop of flax and wheat together was secured when the flax and wheat were sown at the same date, at the rate of three pecks of wheat and two pecks of flax per acre. In the 1900 trials sowing on each acre, four pecks of wheat and ten days later two pecks of flax gave the largest yield, both of wheat and flax. The result of all experiments by this station indicate that where flax and wheat are sown together the flax should be sown soon after the wheat, at least before the wheat is up, in order to get the best results.

VARIETIES OF POTATOES.

Twenty-one varieties of potatoes were planted in the field trial in 1901. None of these were from seed grown at this station, but the seed was secured from the several seedsmen as noted in Table XI. The seed saved from the 1900 crop grown at this station was accidentally injured during the winter by being severely chilled in the cellar. The chilling reduced the vitality of the seed so much that with the unfavorable weather and soil conditions after planting, a very poor stand was secured, hence no yields are given for these old station grown varieties. (See eleventh annual report, page 93.)

The potatoes were planted May 28th and 29th in furrows about four inches deep and three feet and four inches apart, and in hills two feet apart. There were two hundred and ten hills in a row, and fifteen pounds of seed, cut at the rate of two to four eyes to the piece, were planted in each row, the equivalent of one row four hundred and twenty feet long, constituted a plot.

Wet weather and unfavorable conditions caused the potatoes to come up poorly with some varieties, and hindered early cultivation. During the early part of the season, the crop was very backward in growth, but later it made a large growth of vines and a good development of tubers, yielding an average crop. Frost killed the vines September 18th. The potatoes were dug October 24th, when the tubers even of the late maturing varieties generally seemed hard and ripe.

Table XI gives the results of the trial and a brief description of the several varieties tested.

The number of hills harvested is noted for each variety in this table, and the yield has been calculated according to the number of hills harvested, and not according to size of the plot planted. Thus, the poor stand of some varieties is not made to reduce their yield per acre, the yields given showing the relative yield per hill rather than the actual yield per acre from each plot.

Table XI.—Varieties of Potatoes—Crop of 1901.

Bulletin Number	Variety	Where From	Stage of Maturity at Frost, Sept. 18	No. of Hills Harv'd	Average Size of Tubers	Shape	Color	Depth of Eyes	Fingers and Toes—Per Cent	Mealiness—Per Cent	Flavor—Per Cent	Yield Per Acre—Bushels	Marketable—Per C.	Small—Per Cent	Scabby—Per Cent
80	Harvest King	Salzer Seed Co.	Green	203	M. large.	Oblong, irreg.	White	Shallow	5	85	80	164.8	54	17	29
81	Mark Hanna	Salzer Seed Co.	Green	185	Large	Oblong, flat.	White	Shallow	....	85	75	171.6	95	15	
82	Salzer's Good Times	Salzer Seed Co.	Ripe	198	Medium.	Round	Red	M. shallow	....	80	75	129.8	53	13	34
83	Million Dollar	Salzer Seed Co.	Green	198	M. large.	Oval	L. russet.	Shallow	....	75	75	181.1	88	7	5
84	All the Year Round,	Salzer Seed Co.	¾ ripe	154	M. small.	Medium long	R. russet.	Shallow	5	90	90	163.6	33	13	54
85	Sunlight	Salzer Seed Co.	Half ripe	200	Medium.	Medium long	L. russet.	M. deep	2	95	90	207.5	39	30	31
86	Daughter of Rose	Salzer Seed Co.	Green	155	Large	Oblong	R. russet.	Deep	5	88	90	199.2	54	15	31
87	Earliest Six Weeks	Wm. Rennie, Toronto	¾ ripe	188	Medium.	Oblong, oval.	R. russet.	Medium	15	90	95	138.5	63	19	18
88	Aristook Gem	Wm. Rennie, Toronto	In blossom	183	M. small.	Medium long.	White	Medium	12	90	80	162.8	47	23	30
89	Uncle Sam	Wm. Rennie, Toronto	Green	169	Medium.	Oblong, flat.	White	M. shallow	....	80	70	125.9	82	15	3
90	Rose of the North	Wm. Rennie, Toronto	N'ly green.	181	Medium.	Medium long.	R. russet.	Medium	Tr..	90	90	174.2	57	21	22
91	Vigorosa	L. L. Olds, Clinton, Wis.	Green	59	Medium.	Oblong	R. russet.	Medium	3	85	80	110.4	56	29	15
92	Sir Walter Raleigh	L. L. Olds, Clinton, Wis	Green	144	M. large.	Oblong, flat.	White	Shallow	....	75	70	116.8	89	8	33
93	Bovee	L. L. Olds, Clinton, Wis.	N'ly green.	107	Medium.	Oblong	Russet	Medium	3	95	95	132.5	71	16	13
94	Home Grown Acme	L. L. Olds, Clinton, Wis,	⅔ ripe	154	Medium.	Oblong	R. russet.	M. shallow	Tr..	90	90	84.84	53	26	21
95	Banner	L. L. Olds, Clinton, Wis.	Green	159	Medium.	Flat oval	C. russet.	Shallow	....	75	70	97.8	88	10	2
96	Hammond's Wonderful	L. L. Olds, Clinton, Wis.	Green.	173	M. small.	Long	G. russet.	Shallow	Tr..	85	85	112.8	75	25	
97	Maule's Commercial	L. L. Olds, Clinton, Wis.	N'ly green.	119	V. large.	Oblong, flat.	R. russet.	Deep	Tr..	80	75	133.7	80	8	12
98	Livingtone	L. L. Olds, Clinton, Wis.	Green	182	M. large.	Oblong, irreg.	C. russet.	Shallow	Tr..	95	85	130.7	55	15	30
99	Carmon, No. 3	L. L. Olds, Clinton, Wis.	Green	182	Medium.	Oval	Cream	Shallow	....	75	65	106.8	83	11	6
100	White Mammoth	L. L. Olds, Clinton, Wis.	Green	202	M. large.	Oblong	White	Medium	....	80	80	138.9	77	8	15
101	Giant Divide	L. L. Olds, Clinton, Wis.	Green	198	Medium.	Medium long	Cream	Shallow	Tr..	85	80	158.4	68	11	21

TABLE XII.—VARIETIES OF POTATOES GIVING HIGHEST YIELDS IN 1901.

Bulletin Number	Variety	Yield Per Acre—Bushels	Harvest Season
85......	Sunlight	207.5	.Medium early
86......	Daughter of Rose	199.2	...... Medium
83......	Million Dollar..........................	181.1	..........Late
90......	Rose of the North....................	174.2	...... Medium
81......	Mark Hanna............................	171.6	.... Late
80......	Harvest King	164.8	..........Late
84......	All the Year Round....................	163.6	.........Early
88......	Aristook Gem..........................	162.8	..........Late
101.....	Giant Divide...........................	158.4	..........Late

This station is propagating a few varieties of potatoes for distribution among the farmers of this state. The station has on hand about fifty bushels each of experiment station No. 39, and experiment station No. 47. (See eleventh annual report.) Experiment station No. 39 was originally the "Early Andes," but has been grown and selected for several years at this station, and has proven to be one of the best yielding early sorts. Experiment station No. 47 was originally the "Rural New Yorker No. 2," a medium late variety, but several years selection at this station has made it earlier and of better quality than the original seed. These potatoes will be distributed in lots of from one to two bushels at the price of one dollar per bushel including sack.

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WHEN TO PLOW FOR WHEAT.

In an eight year's trial of continuous wheat cropping, at this station, the results of plowing in the spring and fall, and at different times in the fall are shown in the following table:

SUBMARINE RESULTS OF AN EIGHT YEAR'S TRIAL, 1892-1899 INCLUSIVE.

Number of Plots in the Trial	When Plowed	Total Yield Per Acre in Eight Years—Bushels	Average Yearly Yield Per Acre—Bushels	Presence of Weeds in 1899—Per Cent
1.......	Spring............................	131.3	16.4	60
5.......	Average of all fall plowed plats.....	145.8	18.2	16
3.......	Early fall, last of September	138.1	17.3	20
1.......	* Middle fall, middle of October, clover in wheat annually........	148.6	18.6	15
1.......	Late fall, first of November.........	150.7	18.8	5

* A little clover was seeded with the wheat each spring on this plot and was plowed down each fall. This has made the yield from middle fall plowing larger than it otherwise would have been.

In this trial fall plowing has given an average yearly yield of 1.8 bushels more wheat per acre than spring plowing, and the late fall plowing has produced larger crops on the average than the early or medium fall plowing. In the column headed "presence of weeds," it will be noticed that at the end of the experiment, in 1899, the spring plowed land has become much weedier than the fall plowed pieces. These weeds were mostly wild oats.

Below are given the results of another trial which has been conducted for five years, 1897-1901 inclusive. This trial includes forty one-fourth acre plots, twenty spring plowed and twenty fall plowed ones.

SPRING VERSUS FALL PLOWING FOR WHEAT—RESULTS OF FIVE YEARS' TRIALS, 1887-1901 INCLUSIVE.

When Plowed	Yield Per Acre					
	1897—Bushels	1898—Bushels	1899—Bushels	1900—Bushels	1901—Bushels	Average—Bushels
Spring	17.0	28.8	18.3	9.7	12.9	17.3
Fall	22.8	28.1	20.2	6.3	20.4	19.5

In the above trial as an average for five crops, the fall plowed land has yielded 2.2 bushels more per acre than the spring plowed land. It will be noticed, however, that in two years out of the five, the crop from the spring plowing was larger than that from the fall plowing.

The conclusion from the results of these trials is that fall plowing is more nearly sure to produce a good crop of wheat each year than spring plowing, and the average yield is in favor of the fall plowed land. However, from the data, it appears that about once in two or three years, spring plowing will give the larger yield, and it is hard to predict in the fall which line of plowing will produce the larger crop the next season.

Lack of time in the spring is a great incentive for plowing in the fall for wheat and other early grains. As a rule it is not advisable to fall plow for late planted crops. Stubble ground is more moist in the spring than the fall plowed land, and in a dry season like 1900, the yields are favorable to early spring plowing.

SHALLOW VERSUS DEEP PLOWING.

The following table gives the results of shallow versus deep plowing for wheat in a five years' trial, 1897 to 1901 inclusive, with fall plowing:

Year	Yield Per Acre	
	Shallow Plowing, 3 to 4 Inches Deep—Bushels	Deep Plowing, 6 to 7 Inches Deep—Bushels
1897	21.5	21.2
1898	24.1	24.5
1899	19.5	20.6
1900	5.9	7.1
1901	19.9	18.5
Average	18.2	18.4

The above trial was made upon fall plowing. Three years of the five, deep plowing gave the larger yields, but the average is only .2 of a bushel per acre in favor of deeper plowing. Throwing out the year 1901, when the shallow plowing yielded the best crop, probably by reason of the excessive rainfall, the average yields by the two methods compare as follows:

Deep plowing ....18.4 bushels per acre
Shallow plowing .. ..17.8 bushels per acre
Difference .... 0.6 bushels per acre

The results do not show a strong difference of the deeper plowing, but there is sufficient difference in the crop to recommend deep in preference to shallow plowing.

An experiment upon spring plowing was carried on for three

consecutive seasons. The results are shown in the following table:

Year	Yield Per Acre	
	Shallow Plowing, 3 to 4 Inches Deep—Bushels	Deep Plowing, 6 to 7 Inches Deep—Bushels
1897	17.6	17.4
1898	26.7	29.3
1899	17.6	17.9
Average	20.6	21.5

On the spring plowing as an average for the three trials, .9 of a bushel more wheat per acre has been produced annually by the deeper plowing.

DISC VERSUS MOULDBOARD PLOWING.

The results of a three year's trial of disc versus mouldboard plowing for wheat, both in the fall and in the spring are given in the following table:

TABLE SHOWING YIELD OF WHEAT PER ACRE.

Year	Disc Plowing		Mouldboard Plowing	
	Fall—Bushels	Spring—Bushels	Fall—Bushels	Spring—Bushels
1897	24.4	16.6	21.8	17.2
1898	26.8	24.7	28.1	29.2
1899	17.2	14.9	20.5	18.1
Average	22.8	18.7	23.5	21.5

In 1897, the first year of the trial, the yield on the fall plowing from the disc plowed land was 2.6 bushels greater per acre than from the plots plowed with the mouldboard plow. On the spring plowing the yield was .6 of a bushel less per acre by the disc plowing than by the mouldboard plowing. Continuing the use of the disc plow upon the same land has produced relatively smaller yields each year, when compared to the crop from the ordinary plowing, the average decrease per acre being .7 of a bushel on the fall plowing and 2.8 bushels on the spring plowing. The first crop from the disc plowing was the only one which exceeded or equaled that from the mouldboard plowing.

In the dry season of 1900, the trial was continued upon the same plots on fall plowing. The average yield from the disc plowed land in that season was 5.5 bushels per acre, while that from the ordinary plowing 6 bushels per acre.

In the spring of 1900 a single plot was plowed with the Bradley sulky disc plow and another beside it was plowed with a mouldboard plow. Both plots had previously been plowed for three years with the Secretary disc plow, having been used in the experiment reported above. The yields from the two plots in 1900 were as follows:

Mouldboard plowing	13.2 bushels per acre
Disc plowing	12.7 bushels per acre
Difference	0.5 bushels per acre

In all of the above trials with the disc plow, except the last one given, the old John Deere Secretary disc plow was used as opposed to the John Deere Walking plow AX No. 5.

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TRIALS WITH DIFFERENT MAKES OF DISC PLOWS.

Several disc plows have been tested on the college farm as follows:

1. John Deere Secretary disc plow.
2. Tiger disc plow, manufactured by the Stoddard Manufacturing company, Dayton, O.
3. Rock Island disc plow, manufactured by the Rock Island Plow company, Rock Island, Ill.
4. Bradley disc plow, manufactured by David Bradley Manufacturing company, Bradley, Ill.
5. Bissell rotary plow, manufactured by the Bissell Manufacturing company, South Bend, Ind.
6. Chattanooga-Hancock disc plow, manufactured by the Sattley Manufacturing company, Springfield, Ill.

The station began using the Secretary disc plow in the fall of 1897 and continued the experiment upon the same ground for three years, sowing wheat each season. The season following the first plowing, the largest crop of wheat produced was from the disc plowed ground. The next season the yield fell a little below that of the ordinary plowing, and the third season the yield averaged three to four bushels less on the disc plowed ground than from the ordinary plowing. A continuous trial has not been made with any of the other plows. I am sure, however, that nearly all of the more recent disc plows do better work than the old Secretary disc. The chief fault which I find with the old Secretary

plow is that it did not cut and turn all of the soil; it did not cover all of the stubble,, and it leaves the ground in a rough, furrowed condition.

The Tiger disc plow does better work than the old Secretary disc. It cuts nearly all that it turns, but leaves the soil in a more broken and loose condition than does the mouldboard plow. It does not cover as well as a good mouldboard plow will do. When used this plow should be followed almost immediately by a harrow or some other cultivating tool to surface and pack the soil. I have tried the gang, triple and quadruple disc plows. They are rather awkward in construction, and I do not think the draft for the width of furrow turned is much less than that of the mouldboard plow. It was observed that the draft in proportion to the width of furrow turned decreased as the number of discs was increased.

The work of the Rock Island plow was similar to that of the Tiger disc. (I used the triple disc in this trial.)

The Bradley disc plow is a neat, well made plow and easy to handle. When the soil was in good plowing condition, this plow did excellent work, practically equal to that of the mouldboard plow. I saw little difference in the draft of it, as compared with the mouldboard plow. I have used both the gang and the sulky disc and like the sulky much better than I do the gang. When the ground was in a wet condition the Bradley disc refused to turn the soil properly.

The Bissell plow is so constructed that the disc may be replaced by mouldboard bottoms. This plow is not a success either as a disc or mouldbord plow. I have tried only the gang at this station.

Late this fall I tried the Chattanooga-Hancock plow. The plow which we used was a triple disc, cutting thirty-six inches. This plow was easily drawn by four horses, while turning a furrow slice five inches thick. The ground was very wet when the plow was tried, yet the soil was turned almost perfectly and was left in even better condition than the mouldboard plow left the soil on the same day. This plow cuts off all the land that it turns. I noticed that it missed a few rose bushes, otherwise its work in cutting a smooth, clean furrow was equal to that of the mouldboard plow. The Hancock plow, like the other disc plows, leaves the ground in a more loose and broken condition than the mouldboard plow does, and should be followed by a harrow or other surfacing tool. This plow is simple in construction and is very handy in turning one way, when you are plowing around the land, but it is almost impossible to back furrow with it and make corners. The plow seems also to have less side draft than any of the other disc plows used at this station.

I am not yet ready to recommend any disc plow as preferable to the best mouldboard plows for general use on North Dakota

farms. If you have a very hard gummy soil in which it is almost impossible to keep the required depth with the mouldboard plow, the disc plow may be used very advantageously. Every large farm in North Dakota might profitably use one or more disc plows, but it would not be practicable at the present time to wholly replace the mouldboard plow by the disc plow upon any farm in North Dakota.

I do not advise farmers to purchase disc plows at the present time, except after a thorough trial on their own farms. I believe that ultimately when the disc plow has been fully perfected, that it will be a success. These plows should be tried in all parts of the state, but they should be introduced at the expense of the manufacturers and not at the expense of the farmers.

A. M. TEN EYCK.

BROME GRASS.

REPORTS FROM DIFFERENT COUNTIES IN NORTH DAKOTA AND AT THE STATION.

The county reports herewith submitted were not included in the last annual report by reason of a lack of space, but their importance as representing the results obtained with this grass during the dryest season which North Dakota has exeprienced during many years, leads me to introduce them here. In my tenth annual report I informed you that I had sent seed of this grass for trial to every county in the state. I have selected representative reports from the 100 received to show their results with it.

Following are their reports:

J. W. Foley, Medora, Billings Co., N. D.

I had no success with the brome grass seed you sent me. Very little of it came up, and what came up did not grow. I divided my seed with the neighbors, and they had no success.

Ludvig Lee, Fingal, Barnes Co., N. D.

I did not have enough to know how it will yield. I think it will make very good pasture.

L. A. Knoke, Willow City, Bottineau Co., N. D.

My brome grass seed was sown May 20, 1898. It all grew, and was about six inches high in the fall. The brome grass was two and three inches high in the spring, before the native grass had started. It was destroyed by cattle, but since it has had a chance it has done well and stands from seven to fifteen inches now (June 9, 1899), and promises a good crop.

J. O. Smith, Casselton, Cass Co., N. D.

In the spring of 1899 I sowed twelve acres of brome grass by itself, and it was good, and this year would have yielded about two tons per acre if cut for hay, but I saved it for seed. After cutting for seed it grew very thick, and made splendid pasture.

H. T. Helgesen, Milton, Cavalier Co., N. D.

I pastured two cows on two acres of brome grass, and during the drouth they just kept it even, but after the rains came, it grew as high as their knees in spite of them.

It is the best grass for pasture I ever saw.

H. S. Nichols, Oakes, Dickey Co., N. D.

I have been experimenting with brome grass for some time and I am pleased with it.

I think it is just the grass for this country. I think it will yield from one to two tons of hay per acre. It is good for pasture.

Fred H. Martin, New Rockford, Eddy Co., N. D.

I sowed the seed which I received in 1899. The first year it grew splendidly. The second year it did not grow long, but stooled out wonderfully. I do not think it has an equal for pasture. I sowed more last spring and had a good catch and it made a good growth for this year.

William Barry, Niagara, Grand Forks Co., N. D.

The excessive drouth of last summer, (1900) prevented the harvesting of any brome grass seed. I consider it an excellent grass and intend to sow all I can get next spring.

J. H. Mulroy, Hannaford, Griggs Co., N. D.

I sowed the brome grass seed which I received from you on May 29, 1899. I also sowed seven acres more which also made a good stand. I consider it a first class grass for pasture. I have about eighty bushels which I will sow next spring.

Geo. S. Roberts, Dawson, Kidder Co., N. D.

During the past year or two we have let the stock run at large, consequently the brome grass had no chance. None of our grasses grew very much last summer till after the rain came in July. I think the brome grass would be all right if it had a chance and proper attention.

C. A. Hanson, Towner, McHenry Co., N. D.

I sowed the brome grass seed you sent me according to directions. It did not do well the first year, but the second it did better. I cut it for hay, getting about two tons per acre. I then pastured it and it remained green until the frost came.

Wishek & Wiles, McIntosh Co., N. D.

My brome grass seed was sown and came up nicely. Will report on it next year.

W. J. Graham, Walhalla, Pembina, Co., N. D.

In the spring of 1898 I sowed five pounds of brome grass seed upon the bottom land of the Pembina river. It made a moderate showing the first year and gave splendid satisfaction the second and third years. In the spring of 1899 I sowed 120 pounds on eight acres, with one bushel of barley per acre as a nurse crop. I have had splendid results from my brome grass meadow through pasturing it.

M. V. Dahl, Barton, Pierce Co., N. D.

My brome grass made a good stand, but I did not cut it. I believe it is the coming grass in the northwest.

W. E. Goozee, Devils Lake, Ramsey Co., N. D.

Last year was very unfavorable for my brome grass, it was short, but very thick on the ground. I think it will be a good grass.

W. W. McIlvain, Lisbon, Ransom Co., N. D.

I think brome grass will yield from two to two and one-half tons per acre. Much depends on the season. I think it is excellent for pasture.

Joseph Schiller, Great Bend, Richland Co., N. D.

In the spring of 1898 I sowed three pounds of brome grass seed with oats on three-eighths of an acre of good ground, it was very thin in the fall. In 1899 I harvested seventy-six pounds of good seed off of the piece. These seventy-six pounds I sowed with barley in the spring of 1900, but the season was too dry for the seed to grow. I have left it to see what it will be like next year. The piece I sowed in 1898 did not grow any seed in 1900 on account of the drouth, so I pastured it.

F. R. Miller, Grass Lake, Rolette Co., N. D.

I received one pound of brome grass seed and sowed it, I have neither hay nor seed off of it, as I pastured the ground I had it sown upon. I regard it a good grass for pasture. It stays green later in the fall, and is green earlier in the spring than the prairie grass.

Carl Hamman, Richardton, Stark Co., N. D.

My brome grass seed was sown in May, 1899. It was green late in the fall, and green until summer this year, when the dry weather prevented me from getting any seed. It is a good pasture grass.

W. B. Allen, Jamestown, Stutsman Co., N. D.

I am well pleased with brome grass seed I received. It stood the drouth well last summer. I am pasturing my hogs on it and they do well.

Hugo Gailfus, Picton, Towner Co., N. D.

I sowed four acres of brome grass seed in 1899. It was very thin last spring, (1900), but it thickened up enough in the fall to cut one load off of it. My horses are very fond of it.

Chas. McKissick, Mayville, Traill Co., N. D.

My brome grass seed was sown in May, 1899. It was green late stroyed by hail this season. It was as green as could be during the dry weather, while timothy was all dried up. I think it is a good grass for pasture.

David Desautel, Grafton, Walsh Co., N. D.

I received five pounds of brome grass seed from the government in the spring of 1898 and sowed it, in 1899 I harvested twenty-one pounds of seed from five pounds.

In 1899 I bought four bushels of brome grass seed and sowed it. This year was too dry to get any seed, so I cut it in July for feed, getting two loads from four acres. I cut the second growth

in October, but the season was too wet to save it. I think brome grass will be better for pasture than for hay.

P. B. Anderson, Manfred, Wells Co., N. D.

My brome grass seed was sown on May 30, 1899. The first year it did not make much of a stand, but this year it stooled out and was quite thick. Owing to the dry season it did not grow to much height, and only part of it headed out. My opinion is that brome is the only grass for this locality.

M. L. Ayers, Dickinson, Stark Co., N. D.

I used the brome grass seed you sent me on my lawn. It makes a good lawn grass, but it is a little coarse.

T. L. Adam, New Rockford, Eddy Co., N. D.

I sowed the brome grass seed you sent me in June, 1899, with a quantity of Kentucky blue grass on my lawn. The conditions were favorable, but very little of it came up, and none of the blue grass came. After the rain the next summer (July 5th) the brome grass grew rapidly, but in patches and very uneven. It headed out very irregular and some of it was up weeks before the rest. I think it will make excellent pasture.

These reports vary somewhat, and it would be natural to expect them to do so, as they cover a limited acreage and a short period of time, but the uniformity with which they express the belief that it will prove a good pasture grass can leave little doubt of the corrections of the statement. Their reports upon its promise a- a hay plant would indicate that it will prove superior to any other cultivated grass for that purpose in many districts in this state.

The following from Bulletin 45 of this station shows its value as a roughage for horses:

"The stock ate the brome hay somewhat cleaner than they did the timothy. They did exactly the same amount and kind of work and were given practically the same quantity of oats. The work done varied from plowing sixty hours a week to idleness, and averaged little over five hours per working day."

BROME HAY COMPARED WITH TIMOTHY HAY.

Feeding Oats and Timothy	Grain—Pounds	Hay—Pounds	Gain or Loss—Pounds	Work—Hours
Total, 2 horses, 42 days........	1,221.00	1,838.50	35.00	374.00
Average, 1 horse, 1 day........	14.50	21.90	.42	5.20
Feeding Oats and Brome Hay				
Total, 2 horses, 42 days........	1,221.00	1,863.50	65.00	374.00
Average, 1 horse, 1 day........	14.50	22.20	.77	5.20

The experiment showed a little better results from the brome hay, but the weights did not run uniform enough to warrant a

positive decision. Other horses at the station ate thrashed brome straw with a relish. This would indicate that the straw s palatable, and that it probably contains considerable nutrition The large percentage of leaves upon it, and the number of stems which do not head out, add to the palatability and the nutritive value of the brome hay."

It is grown under cultivation in the interior region of Russia, known as Steppes, a region which is high, dry, plains country, similar to our own, with a more rigorous climate than we have in North Dakota. It has been grown at the North Dakota experiment station for ten years and has endured our climate perfectly during that time.

Beside a long list of cultivated grasses at this station, it has proved to be the earliest to start growth in the spring, leading all others by several days. It also shows green in the spring earlier than any native of the prairie. In autumn it shows the same disposition, remaining green correspondingly later than the native and other domestic grasses.

It forms a very dense sod, more dense than any other I have ever seen. It is also a very deep rooting plant. It produces a good yield of hay upon good land, from one and a half to two tons per acre, and I have seen some fine crops of it upon sandy and gravelly soil. The hay is equal to timothy hay in quality, and is little if any harder to cure when cut.

The time of cutting it affects the quality similarly, but to a less marked degree than it does timothy. When timothy ripens its seeds the blades dry and its straw becomes harsh and woody, while brome grass leaves remain green. Brome grass cut high leaves a stubble with leaves enough to have some value for hay.

A pasture upon the station farm at Fargo which consists of eighteen acres of timothy and two acres of brome grass has been pastured with cattle regularly each season for the past five years. The cattle have eaten off the brome grass much more closely than they have the timothy each year. I have seen horses in Williams county crop it off to the ground in the month of June in preference to prairie grass, which was in good condition. In all of the above cases it should be remembered that the brome grass was offered in limited quantity and would be relished as variety, but it certainly proves that it is palatable and of good flavor. I have noticed that the brome grass remains green during dry weather when timothy dries up badly.

The price of seed is high at present, making the cost of seeding a dollar and a half to two and one-half dollars per acre. It yields a large quantity of seed and requires no extra machinery to handle it more than the grain binder and ordinary separator, followed by the fanning mill. That means, it seems to me, that as soon as the country is stocked with seed, it will cost no more

per acre to put land into brome grass than it does now to put it into timothy.

At the Assiniboia experimental farm in Canada, Superintendent Mackay reports a trial with brome grass hay for steer feeding. Two lots of three steers each were fed thrashed brome grass hay and native hay respectively, having in addition equal amounts by weight of silage, meal and bran.

While neither of the comparisons are with roughage which is commonly fed here, it gives a comparison of foods whch must mean that it is not poor in quality. These trials also indicate that thrashed brome grass hay has some value.

Brome grass sown in the spring as early as the land is in good condition has given satisfactory results generally. A good stand has also been secured by sowing the seed as late as the first of August upon land which has been cultivated during the early part of the season to prevent the growth of weeds and the loss of moisture from the ground. Upon land which does not drift, sow it without a nurse crop of any kind. Upon land which is inclined to drift seed about five pecks of oats per acre with it. The oats should be cut for hay when so used, at the time it is in blossom in order that the land may not be dried out by it. It can be sown broadcast by hand and harrowed in with a peg-toothed drag. When sown broadcast use eighteen to twenty pounds of seed per acre. Hon. J. O. Smith, of Amenia, invented an appliance, consisting of a strip of inch board three inches wide with spikes driven through it to correspond with each cup or hole in the seeder box. A short handle is placed in the middle of the strip upon the upper side. By filling the grain box half full or less with seed and agitating it with the appliance described it feeds through the drill in good form. Take the lid off the grain box and let a boy sit astride it and work the agitator. Run the drill shallow—an inch and a half or two inches deep. My observation leads me to believe that fifteen or sixteen pounds of seed per acre will be sufficient when seeded with a drill. The stand of grass during the first season usually looks very poor, insomuch that some of our farmers have plowed up fields of it at the close of the first season, believing that it had failed by reason of poor seed, or from some other cause. It will produce some late summer and fall pasture during the first season. The weeds will spring up on the land the first summer and should be mowed off once or twice to prevent too much shading and to keep the weeds from ripening. It will spread and occupy the ground in a surprising way the second spring and usually produces a good crop of hay or seed as the owner may choose. Very few weeds have an opportunity to grow with it during the second season. If the grass is cut for hay, mow it while it is in blossom. It will then make good hay and produce good aftermath or second growth for

pasture. The yield in following years will also be better than it will when the grass is allowed to ripen seed.

Supt. S. A. Bedford, of the Manitoba experiment farm, says: "In an average season it can be depended upon to produce a profitable crop of seed for two or three years, depending on the seasons, or a crop of hay for three seasons. Its limit for pasturing purposes has not yet been reached.

If the grass is cut for seed it should be harvested when the color of the seed is changing from purple to brown. If cut when the hull covering the seed is purple the seed is light and does not germinate well. If left until the seed coverings are brown, the loss from shelling is considerable. When cut for seed it is bound with the ordinary twine binder and shocked like grain until it is cured. It can then be stacked or shocked and thrashed as desired.

In thrashing it shut the wind off close or much of the seed will be blown over with the straw. Some only allow the heads of the the bundles to be knocked out by the cylinder of the separator and cast the bundle aside. That plan doubtless saves some seed, but it requires a greater outlay of labor. The seed is run through the fanning mill for a final cleaning.

Numerous trials in sowing this grass seed upon prairie sod have proven failures. It succeeds on ground which is too wet for grain, but seems somewhat less adapted to very wet ground than red top.

Regarding the growth of brome grass upon alkali land, Supt. Mackay of the Assiniboia experiment farm says:

"The brome grass on alkali land * * * was grown on two low wet spots in a field of about fifteen acres. The spots are not very large, (three quarters of an acre in both). but before sowing the bottoms were white with alkali. A good many crops have been sown on the field prior to the grass being sown, and no doubt have had some effect on the alkali. * * * The crop of hay upon the three-quarter acre was very heavy, but the land being moist would cause a good crop in any case."

Some have become alarmed by the tenacity and spreading habit of the grass and have inquired whether it can be destroyed when the owner desires to rid his field of it. If the sod is broken shallow as in breaking prairie sod as soon as the hay is taken off. and backset in early fall, it will be practically dead at the time of the backsetting, and will be in good condition for a crop of grain the following spring. If the grass is allowed to ripen seed before it is broken, it will be found much more tenacious of life and much of it will be found growing when backset.

The sod of brome grass is bound together with such a net work of roots that land which is inclined to drift is held together in a manner similar to that which is found with freshly broken prairie sod for two or more seasons.

The present obstacle to sowing brome grass extensively is the price which must be paid for seed.

When the country is once supplied, however, it will probably become as cheap per acre as timothy seed on account of the heavy yield of seed which it makes.

The seed weighs thirteen or fourteen pounds per bushel, the former weight being the one more commonly accepted.

I believe it is destined to fill a much felt want about farm and village homes in this state, where no artificial water supply can be had for watering lawn grass.

It grows thick and leafy and forms a dense tough sod, which will form a green growth of leaves when the soil is quite dry. I know of no other grass so promising for the purpose where it is not possible to water it. When sown for a lawn it should be seeded very thick. I have often thought that this grass might answer for a perennial fire break in ranch districts by remaining green during the season of the year when prairie fires run. I should expect the stock to graze it so closely that it would remain green and succulent.

J. H. SHEPPERD.

POULTRY EXPERIMENTS.

The station has winter quarters for four separate pens of poultry, and, for that reason, can do but a limited amount of experiment work with fowls.

Trap nests, after the model shown in the annual report of the Maine experiment station, for 1898, were made and successfully used in determining the number of eggs produced by each hen. The intense cold and consequent close confinement of poultry during the winter season has led me to make a comparison of the six months of warmer weather to which the heaviest of the egg laying was confined.

The thirty-one hens used in the trial were Barred Plymouth Rocks of pure breeding, and were high class fowls.

Twelve two-year-old and nineteen yearling hens were compared for egg production in this trial. The hens were in three separate apartments of the poultry house and yards, but there were yearling and two-year-old hens in each compartment, which would seem to guarantee similar conditions for the fowls upon each side of the trial.

The records for one month of seven yearling hens and of five two-year-old hens were accidentally destroyed; but, as that con-

stitutes 2.4 per cent of the old hens and 2.7 per cent of the young ones, it practically balances.

ONE AND TWO-YEAR-OLD HENS COMPARED.

	Number of Eggs Laid	
	Total in 180 Days	Average Per Hen in 180 Days
Twelve two-year-old hens........................	189	15.75
Nineteen one-year-old hens......................	939	49.42

The results above noted need little comment and indicate that it does not pay to keep two-year-old hens for egg production. The yearling hens produced an average of 49.4 eggs, while the two-year-old ones laid an average of only 15.7 eggs per head, which is a proportion of 3.3 to one in favor of the yearling hens.

The trial indicates that the poultry keeper takes little chance in sacrificing hens which are more than one-year-old each season.

BREEDING FOR EGG PRODUCTION.

There is ample opportunity to select individuals which are superior to the average as layers; and there is, also, an opportunity to select individuals which are poor egg producers, the range being from 105 eggs in 180 days to none. One-year-old hens numbers eighteen and nineteen, with records of one and nine eggs respectively as a total for six months during the laying season, indicate that, in addition to age, individuality is a matter of importance.

The six best laying one-year-old hens produced an average of eighty-three eggs during the six months, while the poorest laying six hens in the flock confined in the same quarters, and of equal age, produced twenty-three eggs, or little more than one-fourth the number laid by the six best.

The ordinary poultry grower cannot afford to take the time necessary to keep records and select the best laying hens, but I can see no reason why persons producing breeding stock cannot select their fowls upon such a basis, and the poultry grower can afford to pay a handsome dividend to breeders who will, by heredity, make hens produce even one-fourth more of eggs or of gross weight of meat from a given number of fowls without materially increasing the quantity of food required.

Twelve two-year-old hens were placed before the judge of the North Dakota and Northwestern Minnesota Poultry association, Feb. 2, 1900, when they were pullets. W. S. Russell was the expert judge who passed upon them. The following table shows how the six highest scoring hens compare with the six best lay-

ing ones which could have been selected by means of a recording nest.

LAYING RECORD OF THE SIX HIGHEST SCORING HENS.

Number of Hen	No of Eggs Laid in 180 Days	Scored by Expert Judge	Date Hatched
206	18.0	92.0	1899
211	17.0	92.0	1899
209	12.0	91.5	1899
203	36.0	91.0	1899
205	33.0	90.5	1899
213	7.0	90.0	1899
Total for six hens	123.0	547.0	
Average per hen	20.5	91.2	

LAYING RECORD OF THE SIX BEST LAYING HENS.

Number of Hen	No. of Eggs Laid in 180 Days	Scored by Expert Judge	Date Hatched
204	36.0	91.0	1899
205	33.0	$90\frac{5}{10}$	1899
208	32.0	89.0	1899
206	18.0	92.0	1899
211	17.0	92.0	1899
201	15.0	89.0	1899
Total for six hens	151.0	543.5	
Average per hen	25.2	90.6	

The above tabular statements show that the six fowls ranked highest by the judge, and which would, ordinarily, bring the highest price as fowls to breed from, produced an average of 20.5 eggs, while the six best laying hens selected from the flock laid an average of 25.2 eggs, or, practically, one-fourth more eggs. It will thus be seen that the trap hen nest offers an opportunity for breeding, egg-producing, and, hence, valuable hens much more certainly than an expert judge is able to do.

J. H. SHEPPERD.

HORSE AND CATTLE BARNS BUILT IN 1901.

After the destruction of the old college barn by fire Jan. 4, 1901, Prof. Shepperd corresponded with a number of agricultural colleges and obtained plans of their respective stock barns to aid in a suggestive way in planning the buildings to be constructed at this institution, which were two separate barns to take the place of the former combination one.

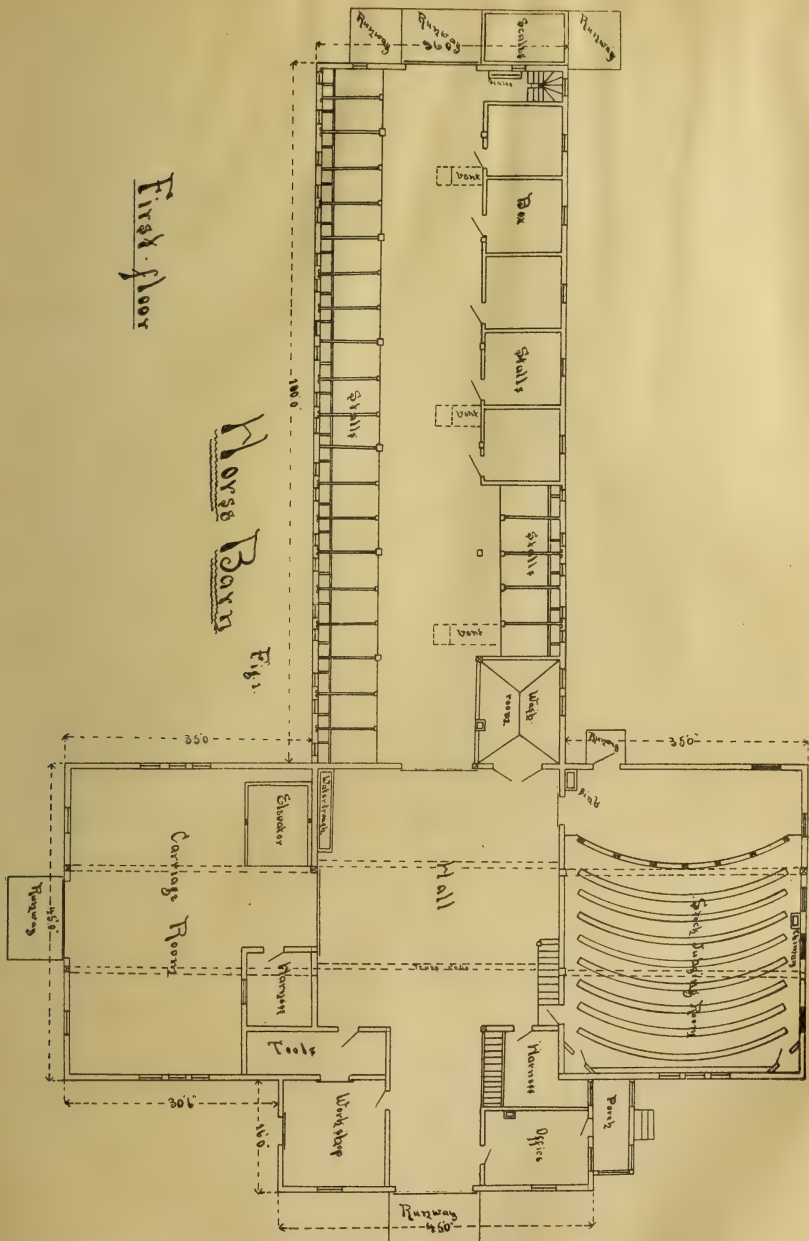
The ideas worked out by Prof. Shepperd were submitted to Hancock Bros., architects, who drew the plans and specifications for

HORSE BARN OF THE STATE AGRICULTURAL COLLEGE AND EXPERIMENT STATION.

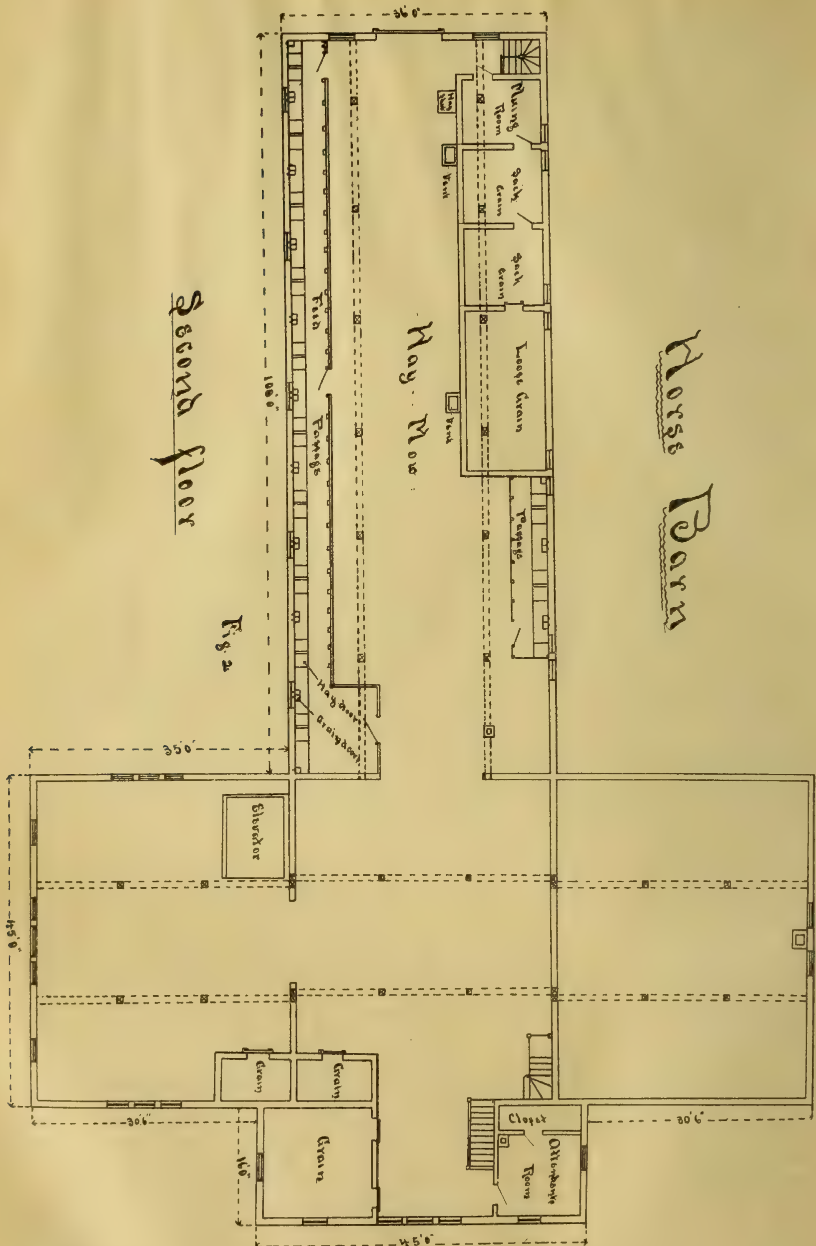
the barns recently completed, copies of the plans of which are submitted herewith.

The barns stand upon brick foundations; and are frame structures two stories high. They are boarded with ship lap on both sides of the studding, while the outside is covered with weather boarding. The shingles were dipped in a shingle stain before being placed on the roof, thus increasing their durability. The silo of the cow barn is built of brick, and is separate from the barn. Both barns are connected with the city water works and sewerage system.

The Horse Barn. The main part of the horse barn is forty-five feet wide and 106 feet long, with twenty feet studding. On the west of this is a small wing ten feet long and forty-five feet wide,



PLAN OF FIRST FLOOR OF THE HORSE BARN OF THE STATE AGRICULTURAL COLLEGE AND EXPERIMENT STATION.



PLAN OF SECOND FLOOR OF THE HORSE BARN OF THE STATE AGRICULTURAL COLLEGE AND EXPERIMENT STATION.

with studding of the same height as the main part. On the east is a wing which forms the horse stable proper. It is thirty-six feet wide and 100 feet long, with sixteen foot studding.

First Floor. In the south end of the main structure is the stock judging room, which is supplied with a sloping floor, a pit or arena in front large enough for five head of stock to be shown at a time in addition to leaving space enough for a veterinary operating table. It is supplied with large windows on the south and west to insure an abundance of light. The harness rooms, a large hall, and a carriage room are also located upon this floor. An elevator for conveying heavy vehicles and other articles to the upper floor is located in the carriage room, as shown in the plans submitted herewith. The west wing contains an office, a work shop, and stairs. The east wing contains twenty-five, 5ft. single stalls, the partitions between which are built of 2x8 inch planks 4 feet high, surmounted by iron bar trimmings.

The mangers are divided by the stall partitions; and in one corner of each, at the base of the grain chute, is the feed trough.

The hay racks have bar iron fronts, with chutes and covers above.

The box stalls are 11x12 feet; shiplapped on both sides, with upper and lower-half doors.

The barn is provided with a carriage wash room 12x15 feet, with a sloping floor centering towards a sewer drain. The wash-room has a chimney and is supplied with a stove. A wagon scale is located outside of the barn, as shown in this plan, with the weigh beam rising inside the building.

Three large ventilators are placed in this barn. They extend through the floor of the hay mow above the horse stable, and are provided with shutoffs.

Second Floor. (Figure 2.) On this floor are the attendant's rooms and a closet, feed bins of various kinds, a carriage and sleigh storage room, and the elevator landing, as shown in the accompanying drawings. The hay mow is directly above the horses. Along the walls of the mow is a feed passage, boarded up with ship lap, and supplied with doors leading into it at several places. In this passage are the hay and grain chutes, which enable the feeder to weigh his grain and roughage at the bins and in the mow; and to feed each a known amount without carrying the rations separately down stairs.

Two flights of stairs lead to the second floor—one landing near the attendant's room; while the other passes from the east end of the horse stable to the feed passage and grain bins on the second floor.

The floors in the offices and harness rooms are of common boards, covered with No. 1 flooring. The remainder of the first floor is laid with sized and surfaced oak planks; the floor in the single horse stalls is laid lengthwise, and has a slant of two

inches from front to back. The second floor is laid with No. 3 fir flooring throughout. The attendant's room and the office are ceiled with fir ceiling.

THE CATTLE BARN.

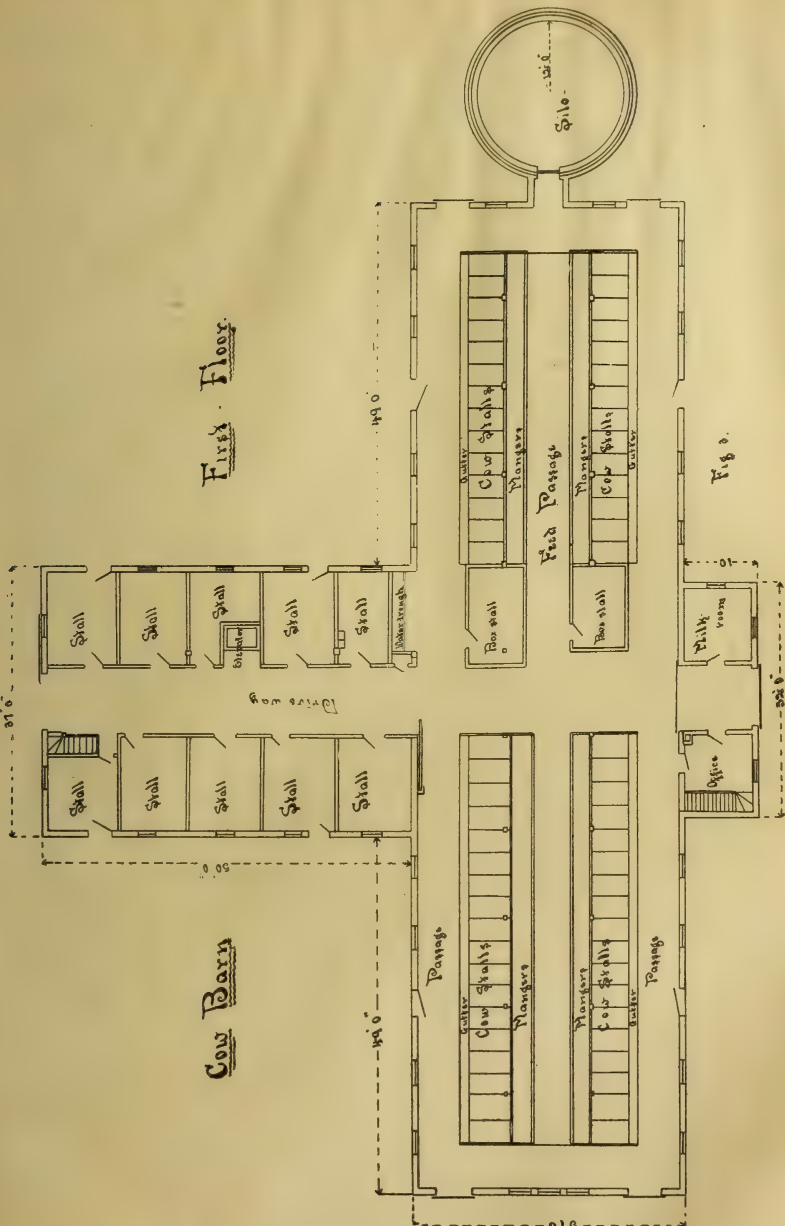
The main part of the cattle barn stands north and south and is 135 feet long and 37 feet wide. It holds two rows of stock facing the center, with a 5 foot feed passage through the middle. The feed passage connects with the silo, which allows the ensilage to be thrown into a small truck, and drawn through the passage way between the mangers, as it is fed to the stock. (See Diagram 3.)

On the east is a projection 10 feet long by 32 feet wide, con-

CATTLE BARN OF THE STATE AGRICULTURAL COLLEGE AND EXPERIMENT STATION.

taining an office, a stair footing, and a milk room. On the west is a large wing 50 feet long by 37 feet wide, with two rows of box stalls of different sizes, stairs, watering trough, and closets. The building has 16 foot studding throughout.

Stalls. The stalls are of the Bidwell pattern, and are of different sizes ranging from 3 feet to 3 feet 4 inches in width; and they are 5 and 6 feet in length. The manger is 3 feet wide and 8 inches high, and is movable. It has a fence like portion in the middle which prevents the animal walking forward through it.



PLAN OF FIRST FLOOR OF CATTLE BARN OF THE STATE AGRICULTURAL COLLEGE AND EXPERIMENT STATION.

Agri. Col.—7

This stall can be adjusted to suit the size of the animal. The gutters are 16 inches wide and 6 inches deep at the back, with an inch slope from front to back. The box stalls are of different sizes, as shown in the plans.

Second Floor. The second floor has feed bins, attendant's room, and hay mows. The hay is taken in by means of hay forks to all parts of the barn.

The floors of the office and milk rooms are double, with building paper between. These rooms are ceiled with western fir ceiling. The remainder of the first floor is laid with sized 2x10 fir planks. The planks constituting the stall floors are laid with western fir throughout.

The Silo. The silo is round in form and is 24 feet in diameter, inside measurement. The wall is made of brick, 28 feet high and 20 inches thick, with a dead air space in the center of it. The floor and wall are cemented with the best grade of cement. A dormer window in the silo roof serves as an intake for green corn or other material with which the pit is filled. A second dormer window on the opposite side of the roof furnishes light.

E. G. SCHOLLANDER.

THE EDGELEY SUB-STATION.

The last legislative assembly appropriated the sum of two hundred and fifty dollars to be expended upon experiment work at the Edgeley sub-station and the work was inaugurated. The quarter section of land which the citizens of Edgeley and the surrounding community donated to the experiment station for an experiment farm is situated about a mile and a half south of the village of Edgeley and was used for the trial.

The land is undulating and was in reasonably good condition, in the spring of 1901. The larger part of the quarter section has been cropped to grain for several years.

It seemed necessary to fence the portion used for experiment work to scure protection from stock.

A good wire fence was constructed around the twenty acres which lay most uniform and which in every way seemed best suited for comparative trials. The inclosed portion was laid off in one acre plots with suitable passage ways, etc., for easy handling and accurate trimming and measuring of the crops grown.

It is a pleasure to be able to report as much accurate data as the department is able to do for so small an outlay in expenditure. Much credit is due to Hon. B. N. Stone, a member and representative of the board of trustees for his suggestions concerning the trials instituted and for his painstaking and efficient work in making the necessary business arrangements for carrying on the trials.

Mr. James Plott also deserves credit for the accuracy with which he and his sons carried out the details of the work as

planned and for suggestions and information which his experience in the district enabled him to give the writers.

Mr. E. A. Cannon, a student from the agricultural college had immediate charge of the fencing and laying out of the grounds and of the harvesting of the small grain, all of which services were performed in a creditable manner.

The fact that Edgeley is situated over one hundred miles from the central station at Fargo caused a heavy expenditure for car fare and freight, and caused the writers to visit the sub-station no oftener than seemed to be absolutely necessary, as full railroad fare for all transportation constituted one of the heavier items of expenditure. The work begun at Edgeley shows marked results and it is important work for a large district of this state, but if no means is provided for carrying it forward, its value will be limited as results for a single year must always be. The appropriation for the Edgeley sub-station work was for one year only, which leaves no funds for carrying it forward.

A trial which shows a range of from nine to fourteen bushels of wheat per acre for the shallow and deep plowing and that corn land closed the season of 1901 with over 24 per cent of water in the surface three feet, while wheat producing land contained only 10 to 11 per cent of moisture indicates how valuable a study and record of these facts would prove to the people of the farming districts with conditions similar to those represented by the Edgeley sub-station.

The study of the rooting systems of field crops and a trial of forage and grain crops cannot fail to prove of great value to that portion of the state. Trials of rotation methods, drouth resisting grains and sugar beets are important subjects which need investigation for that district of North Dakota.

I would recommend that an annual appropriation of $1,500 be made for the support of the work of the Edgeley sub-station, by the legislative assembly, and I feel that such a sum would bring back many times the amount, in lasting value to that portion of the state.

All of the land in the experimental plots except the east half of plot 16, which is new breaking, consists of old land which has been farmed eight to fifteen years, and quite regularly cropped with grain. The south half of plots 1 to 9 was fall plowed in 1900. The north half of plots 1 to 9 and the whole of plots 10 to 18 were plowed in the spring, before April 28, 1901.

For all crops the fall plowing was prepared with a disc pulverizer, and the spring plowing with a smoothing harrow.

EXPERIMENTS WITH WHEAT.

Plot 3 was sown to Minnesota No. 163 fife wheat, April 30th, at the rate of five pecks of seed per acre. The wheat came up and stooled well making a good stand. The grain was ripe and cut August 5th. The height of the straw was thirty-six inches. The length of the heads two and three-quarter inches. The heads were not well filled and the grain was light and shrunken. The weight of the grain per bushel was fifty-three pounds. Grade No. 3 northern, 90 per cent hard. Yield per acre nine and two-thirds bushels. Inspection clearly showed that the wheat was better on the fall than on the spring plowing.

Plot 5 was sown to experiment station No. 66 fife wheat on April 30th. The west half of this plot was plowed four inches deep and the east half seven inches deep. The wheat made a fair stand on both plots. The grain on each plot was ripe and cut August 7th. The height of the straw was thirty-four inches and the heads were two and one-half inches long. The heads were light and not well filled. The comparative results are shown in the following tabular statement:

Kind of Plowing	Weight Per Bushel—Pounds	Grade	Hard Wheat—Per Cent	Yield Per Acre—Bushels
Deep..............................	55	3 N.	90	9
Shallow............................	56	3 N.	90	14

The shallow plowing yielded 55 per cent more than the deep plowing.

The east one-half of plot 13 was sown to aronautka macaroni wheat on May 2nd. The drill was set to sow five pecks and two quarts of wheat per acre. This wheat made a good stand and was heading July 5th. It was ripe and cut July 31st. The heads seemed to be well filled, but the grain was badly shrunken. The height of the straw was thirty-nine inches and the length of the heads two and one-half inches. Wheat from this plot weighed fifty-six pounds per bushel. The yield per acre was nine bushels.

The east one-half of plot 15 was sown to experiment station No. 66 wheat on May 2nd. This grain was harrowed with a smoothing harrow as follows: May 20th, May 25th, and May 30th. The result of the experiment was an almost total failure of the crop.

Another plot was sown to No. 66 wheat, May 2nd. This grain was harrowed three times as follows: May 20th, May

28th, and June 6th. The result of the experiment was an entire failure of crop.

* EMMER.

The east one-half of plot 13 was sown to emmer, usually called spelt, on May 2nd. The drill was set to sow eleven pecks of barley per acre. This sowed about two bushels of emmer per acre. The grain made a good stand. It was ripe and cut July 31st. The length of the straw was twenty-eight inches and the heads were two and one-half inches long. The heads were plump and well filled, and the grain weighed twenty-eight pounds per bushel and produced eighteen bushels of grain per acre.

OATS.

The alley around the outer edges of the plots was sown to oats. On August 6th, it was noted that the oats had made an excellent stand and were well headed and filled, representing at that date the best appearing and most profitable crop on the grounds. The oat crop in the Edgeley district was generally good last season.

FLAX.

A small plot (.45 of an acre) of spring breaking was sown to flax May 17th. The sod was disced four times and harrowed twice and was in good condition when sown. The flax was seeded with the drill at the rate of twenty quarts per acre. It came up well and made a fair stand and a good growth. The straw stood twenty-six inches high August 8th. The seed yielded at the rate of 6.6 bushels per acre, and weighed fifty-two pounds per bushel. The seed was of good quality.

Plot 4 (old land) was sown to flax May 10th. The flax made a very poor stand on this ground. No yield was taken, but it was observed that the crop was considerably better upon the spring than it was on the fall plowed land.

CORN AND FORAGE CROPS.

Plot 9 was planted to corn May 3rd. In this trial North Dakota No. 100 seed corn was used. The corn was sown with a grain drill; the east half of the plot was seeded in drills fourteen inches apart and the west half in drills thirty-five inches apart. The drill was set to sow three and one-half bushels of oats per acre. This corn was harrowed May 18th, May 25th, and June 6th. The east half of the plot was cultivated June 7th; the west half, July 10th. The corn was badly injured by frost on June 7th. On August 8th the following facts were noted by field inspection. The corn planted in thirty-five-inch drills was about

* Commonly called spelt.

one-half of a stand, and was quite weedy, probably owing to a lack of cultivation. The stalks were about four feet high and the corn was in full tassel and silking. The corn planted in fourteen-inch drills was about one-fourth of a stand, three and one-half feet high and weedy. It was in the silking stage at that date. The yield of fodder from these plots was not taken.

Plot 18 was sowed to corn May 10th. The west half in drills fourteen inches apart and the east half in drills thirty-five inches apart. The drill was set to sow three and one-half bushels of oats per acre. The corn on this plot seemed to be less injured by frost than it was upon the other plots. On August 8th the stand was noted as "fair." The corn was in tassel and stood four feet high in the thirty-five-inch drills and three and one-half feet high in the fourteen-inch drills. Upon that date the soil was mellow and in a fair condition as to moisture as shown by the moisture determinations. (See accompanying tables.) This corn was cultivated as follows: Harrowed May 25th, June 6th and June 21st. The east half was cultivated June 27th. The cultivation had not been sufficient to keep down the weeds. Mr. Plott reports the yield from the whole plot as three tons of fodder per acre.

Plots 6 and 8 were planted to North Dakota No. 100 corn May 10th. The corn came up well but was nearly all killed by the late frost of June 7th. The plot was seeded to German millet about June 15th. On August 6th the millet stood fifteen inches high and was a good stand. It yielded one and one-half tons of hay per acre.

Plot 10 was planted to Mercer corn and kaffir corn on May 9th. The corn was almost entirely killed by frost on June 7th, and the plot was sown to millet.

The west half of plot 12 was sown to yellow Canadian field peas. The peas were beginning to blossom June 26th, and were cut for fodder July 29th. The length of the vines was about two feet. The stand was poor and the yield was not taken.

Plot 14 was seeded to Japanese barnyard grass on May 2nd. drill was set to sow three pecks of flax per acre. On August 8th the grass stood twenty-four to thirty inches high, and was a fair stand. The leaves were wilting and brown at that date, and the crop seemed to be suffering badly from drouth. There was a considerable bottom growth of Russian cactus on this plot. Mr. Plott reported the yield as two-thirds of a ton of fodder per acre.

SEEDING TO GRASS.

The east half of plot 12 was seeded to timothy without a nurse crop. The weeds were mowed twice during the season. On August 8th no timothy could be observed, but there was a heavy growth of cactus on the plot.

Plot 1 was seeded with Austrian brome grass April 30th, at the rate of fourteen to sixteen pounds to the acre, and without a nurse crop. The ground was prepared thoroughly. The fall plowing was disced and the spring plowing was harrowed to make a good seed bed. The seeding was done with a Monitor shoe drill. The weeds were mowed twice during the season. On August 6th it was noted that the plot was weedy, and that the brome grass was thin on the ground, and had made a slender growth. A few spears were noticed, three to four inches high at this date.

The east half of plot 2 was seeded to Turkestan alfalfa, sown with the drill which was set to sow flax at the rate of ten quarts per acre.The ground had been prepared as already noted for the seeding of Austrian brome grass. The weeds were mowed twice on this plot during the season. On August 6th it was noted that the alfalfa had made a very poor stand. Some plants were found which were two to four inches in height. The ground was covered with a thick growth of Russian cactus.

RAPE.

On May 4th the west half of plot 15 was sown to dwarf essex rape in drills thirty-five inches apart. The drill was set to sow two pecks of flax per acre. On August 6th the rape stood about thirty inches high and the plants were large and leafy. The rape made about one-half of a stand. It seems probable that with good cultivation this plant will make a profitable annual pasturing crop for the Edgeley district.

REPORTS UPON POTATOES, SUGAR BEETS AND ARTICHOKES.

Plot 11 was planted to potatoes of several varieties, to sugar beets and to early French artichokes.

The artichokes did not mature and were killed by frost September 18th. The tubers had developed to about the size of hens eggs.

The potatoes were a poor stand.The early varieties, such as the Early Ohio, Early Dawn and Six Weeks yielded best. The Rural New Yorker No. 2, a medium late variety,also proved to be a good producer. Experiments in treating potatoes for scab wth Formaldehyde solution were a practical failure on account of the poor stand.

The sugar beets made about one-half stand. Two samples

were analyzed by Prof. Ladd of this station. The samples were taken on September 28th. His report is as follows:

Variety	Average Weight—Pounds	Per Cent Sucrose	Co-efficient of Purity—Per Cent
Number 5770	1.3	13.32	83
Number 5772	.7	10.52	60

Prof. Ladd describes the beets as not quite ripe.

Mr. Plott estimated the yield at from eight to twelve tons per acre.

SOIL MOISTURE STUDY.

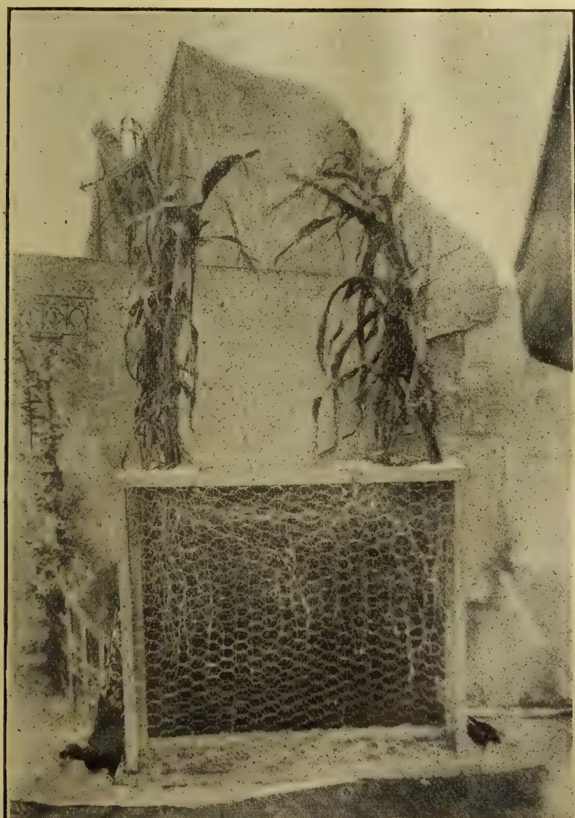
Samples of soil were taken from several of the experimental plots soon after seeding time, May 8th, and moisture determinations were made. The percentages of moisture found in the soil at that date are given in the following table:

Plot No.	Treatment or Crop	Percentage of Moisture			
		1 to 6 Inches	1st Foot	2nd Foot	Average
7	Manured, spring plowed 4 inches deep, left fallow	28.1	25.4	20.7	23.0
9	Spring plowed, 4 inches deep, planted to corn	21.0	21.7	22.5	22.1
5 S—½	Fall plowed, 4 inches deep, sown to wheat	25.6	22.9	15.0	19 0
5 N—½	Spring plowed, 4 inches deep, sown to wheat	23.4	24.1	18.1	21.1
16	Sod not plowed	19.6	22.2	22.9	22.5

It will be observed that there was not a great difference in the moisture content of the soil at seeding time. At about harvest time, at the date the root samples were taken (August 8th) samples of soil for moisture determination were again taken from the several plots which are described in the above table, and which were being cropped with different crops. The percentages of moisture found in the soil of the several plots at the different depths at that date are given in the following table:

Plot No.	Treatment or Crop	Percentage of Moisture			
		1st Foot	2nd Foot	3rd Foot	Average
7	Summer fallow, spring plowed, plowed second time July 25	22.8	26.4	24.0	24.4
9	Corn cultivated	17.1	27.5	38.0	24.2
5 S—½	Wheat stubble, fall plowed in 1900	11.8	9.3	9.4	10.2
5 N—½	Wheat stubble, spring plowed in 1901	10.3	7.4	15.8	11.2
16	Flax on spring breaking	10.9	28.4	25.0	21.4

It will be observed that the largest percentage of moisture was conserved in the summer fallowed land. There was almost as large a percentage of moisture in the corn land as in the summer fallowed land. The surface foot of the corn land was comparatively dry, which was due to the fact that the corn had not been cultivated properly, and there was a considerable growth of weeds which exhausted the water in the surface soil. However, as will be noticed from the table large amounts of water had been conserved in the corn land in the second and third feet. The wheat land is the dryest in each case. The difference in the moisture content of the wheat land and the corn land amounts to about 14 per cent on the average for the three feet of soil.



CORN ROOTS TAKEN AT THE EDGELEY SUB-EXPERIMENT STATION.

A ROOT STUDY AT THE EDGELEY SUB-STATION.

On August 6th to 9th samples of wheat and corn roots were taken at the Edgeley sub-station farm, by the method which has been employed at the central station at Fargo, which is described in Bulletins No. 36 and 43. Figures 6 and 7 are photo-engravings of these samples.

NOTE—The half-tone engraving, representing the specimen of wheat roots taken at the Edgeley Sub-station, was accidentally destroyed at a time too late to permit of another cut being made in time for it to appear in this report.

The sample of wheat roots is not especially good; the wheat was too ripe and the roots were dead, and brittle, and easily washed away by the spray from the force pump. By very careful work, the roots were secured to a depth of three and one-half feet. This seemed to be about as deep as the roots were able to penetrate at the spot where the sample was taken, on account of a layer of shale which appears in the soil at that depth.

At Fargo the roots of wheat have been found to penetrate four to five feet deep.

The sample of corn roots is a very good one and shows the distribution of the roots between two hills, three and one-half feet apart. Some of the roots were five feet long, extending from hill to hill, and two to three feet deep into the soil. The sample shows the growth of roots which had taken place in eighty days. The roots had not yet reached the layer of shale. Some of the vertical roots, however, had reached the depth of nearly three and a half feet. It was observed that the soil of the corn field was much more moist than that of the wheat field. Corn acts as a conserver of soil moisture, and it also leaves a large mass of roots in the soil, which readily decay and supply the food of succeeding wheat crops. At the Fargo station corn has been found to be one of the most valuable rotation crops. For a comparison of the moisture of the soil of different plots, see accompanying tables.

A. M. TEN EYCK.

ACKNOWLEDGMENTS.

During the past year A. M. Ten Eyck, M. S. has assisted me in conducting the experiment work carried on by the department. The greater portion of the work of the department has been carried jointly, while he has become individually responsible for certain portions of it, as will be seen by this report and by other published matter.

Mr. E. G. Schollander rendered efficient aid to this department in the early part of the season by acting as student assistant and later as an assistant on full time. His work has been chiefly in seed breeding, seed selection and in seed distribution. He has

also largely relieved the department from work in farmers' institute meetings by filling a position upon the farmers' institute staff of speakers.

Mr. H. M. Ash has acted as farm foreman during the past season and has become responsible for a large portion of the detail work carried by the department.

Mr. L. F. Seneco has rendered creditable service in field plot and soil work and in preparing and placing exhibits for the station.

My thanks are due Prof. E. S. Keene of the mechanical department of the college for aiding this division by taking photographs, arranging for illustrative cuts, preparing lantern slides and stereoptican apparatus and for aid and suggestion relative to various illustrative material.

Hon. B. N. Stone of Edgeley, a member of the board of trustees aided the department materially in the work at the Edgeley sub-experiment station, as is noted in the body of this report.

J. H. SHEPPERD.

DEPARTMENT OF HORTICULTURE.

To Director J. H. Worst:

Sir: The work of the horticultural department for the year 1901 was along general lines of tree, fruit and vegetable culture. Because of the new conditions existing in the state, particularly as pertains to horticulture, the demand is for demonstration work of a general nature and the building up of improved varieties, rather then for experimentation along special lines. Up to the present time there has been almost no variation from the constantly repeated question "what shall I grow and how shall I grow it?"

It has been the aim of the department to furnish a perpetual reply to the question through its garden and fruit and tree plantations.

About four acres are devoted to the cultivation of vegetables, particular attention being given to onions, celery, cabbage and those other sorts having a considerable market value, and requiring for their profitable production particular methods of cultivation.

The large number of visitors coming to the station each year with the farmer's excursions makes this feature of the work of the department not only a useful, but practically a necessary one.

Owing to the excessive rains of the past season about half of the vegetables were drowned out, and most of the others suffered considerably. In spite of that a creditable showing was made

with cabbage, onions, celery and corn, specimens of these securing premiums over others of their class when exhibited at the Pan-American exposition at Buffalo.

The fruits made a fair showing in yield, and all made a good season's growth. Several apple and plum trees were added to the orchard and forty additional varieties of strawberries were added to the trial beds.

The injury that the bearing beds of strawberries received in May from the severe winds that extended over a period of about three days, showed the necessity of providing protection for small fruits and the tenderer plants.

With this necessity in mind considerable attention has been given to hedges and shelter belts, and the results obtained have created much interest. The hedges proved to be one of the attractive features to the many hundreds of visitors at the station grounds during the past season. The Russian Golden Willow, Buffalo berry, Caragana, Russian Wild Olive, soft maple and wild plum are among the best hedge plants, the Russian willow making the most rapid growth, and being the best for strictly shelter purposes. It is also very attractive when cut to a low hedge, while the bright golden red color of its twigs makes it quite as pleasing in winter as in summer. Several thousand cuttings of this species were sent out last season, and arrangements have been made to continue the distribution in 1902.

The year 1901 demonstrated very clearly the superiority of the Carolina poplar as compared with the cottonwood, which it resembles. The cottonwood is subject to a leaf rust, which in warm wet seasons becomes so bad as to defoliate the trees early in the season. This rust will not grow on the Carolina poplar, which remains green and healthy after the cottonwood has lost all its foliage.

The Russian poplar, (P. centinensis) which has been favorably mentioned in previous reports, also holds its foliage until very late and seems in every way superior to the cottonwood.

ENTOMOLOGY.

In the latter part of May reports of grasshopper ravages began coming to the station. These reports were from widely separated points, but at no one place was the infested area large enough for extended damage to occur. By means of previous reports, bulletins, correspondence, and particularly personal visits the habits of the grasshopper and the proper means of its destruction were matters of pretty general knowledge and whenever it was considered necessary steps were taken to prevent damage.

A visit to the different points, in July and August showed that in many places the migratory locusts had left before depositing their eggs, while at other points, particularly in eastern Barnes,

western Cass and southern Steele counties eggs were being laid in fields here and there.

The attention of the owners was called to the fact, and nearly all declared their intention of plowing the land before the time of hatching of the eggs. In spite of this intention some fields will doubtless be left, but if they are plowed as soon as the insects are found to be hatching, no great harm can result. While the situation is not alarming, it is only the part of good sense to take hold of the matter in good time, and prevent any possible damage.

As has always been observed, whenever the migratory locusts appear the native species become much more numerous, and as many of these breed in the sod, their destruction is not the simple matter as is that of the Rocky Mountain locust. One section of wheat near Fargo was entirely destroyed by these, and many gardens suffered severely, some being totally destroyed.

On a field of cabbages the following remedy was applied with complete success, when the insects were numerous enough to have eaten everything:

Twenty-five pounds wheat bran.

Two pounds white arsenic.

Three gallons cheap molasses.

Mix the bran and arsenic well before adding the molasses. Then add enough water to wet the whole mixture thoroughly, leaving it stiff enough to be scattered broadcast. This preparation remains moist for a long time, and is greedily eaten by the grasshoppers. It is to be scattered broadcast among the plants, a very light sprinkling being sufficient.

PUBLICATIONS.

In September the department issued bulletin No. 49 which is devoted to fruit culture. It gives in some detail the methods of cultivation found suited to this region, and lists the varieties that have succeeded best. Some of the accompanying cuts are reprints from this bulletin.

Respectfully submitted,

C. B. WALDRON,
Horticulturist.

DEPARTMENT OF VETERINARY.

To President J. H. Worst :

Sir: Since making my last report some much needed improvements have been made in this department. I am now occupying four rooms divided into museum, class room and laboratory, all in Francis hall. The office is a well lighted and heated room, and is supplied with library of all the latest books relating to the study of veterinary science. The museum is nicely situated and supplied with tables and cases for the preserving of specimens which I am preparing. The class room is a pleasant room for class work. The laboratory is well lighted and heated and fairly well ventilated. This room is used for the advanced class for dissecting specimens, which are afterwards used before the lecture class and then returned to the museum where they are retained as specimens.

The work in this department has been mostly educational. The winter term of 1901 had seventy-one pupils enrolled. They were taught by lecture how to successfully care for the different domestic animals. The enrollment in the spring term was five, and the class pursued the study of veterinary anatomy, and physiology text book was introduced for the first term, and the entire three months was given to the study of bones and muscles.

During the fall term there were seventeen students enrolled, taking practically the same course as the spring term students did, and during the winter term of 1901 these students are advancing along the same lines.

The laboratory is used for dissecting different animals. These students now meet in the laboratory one hour each day, five days a week and attend clinics once a week.

The regular winter term has enrolled seventy-four pupils, who meet one hour a day, five days a week, and one afternoon a week for clinics. This class is practically taking the same work as has been given the last two winters. The afternoon clinics have been held in the large operating room in the barn, and at these clinics some of the more common operations were performed and fully demonstrated. The symptoms of disease were pointed out, temperatures of the different animals were taken the catheter was introduced by myself and each student in turn Medicines were compounded, and administered both by mouth and hypodermically, as well as in the trachea, jugular vein, and by every practical and often necessary channel. The aim in the entire class has been to bring the student up to as high a point of efficiency in the care of stock as is possible in the time allotted.

The branches which are taught in this department are anatomy, sanitary medicine and surgery, cattle pathology and obstetrics.

Heretofore this department has been so crowded for room both in the barn and laboratory that no experiments have been undertaken, but now that these objections have been removed, I should like to undertake an investigation of a disease that is quite prevalent in this and other western states, and is spoken of as "pinkeye" in cattle. While the loss from this disease has not been very great, it is extremely annoying to stock owners. The disease is now in the neighborhood of the college, so the investigation could be carried on in the laboratory with specimens from the diseased herds.

I have taken part in seven farmers institutes, and have spoken on the diseases of live stock, their cause and prevention.

Respectfully submitted,

J. W. DUNHAM.

STATEMENT

OF RECEIPTS AND EXPENDITURES FROM JULY 1, 1900, TO JULY 1, 1901.

RECEIPTS.

Received from U. S., Hatch Act, March 2, 1887	$15,000.00

DISBURSEMENTS.

Salaries	$ 5,316.52
Labor	6,931.18
Publications	1,187.58
Postage and stationery	137.90
Freight and express	43.26
Heat, light, water, and power	146.80
Seeds, plants and sundry supplies	252.83
Feeding stuffs	775.61
Tools, implements and machinery	65.32
Traveling expenses	125.00
Contingent expenses	18.00
Total	$15,000.00

C. E. NUGENT,
Secretary.

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1913

THIRTEENTH ANNUAL REPORT

OF THE

North Dakota Agricultural Experiment Station

AGRICULTURAL COLLEGE, N. D.

TO THE

GOVERNOR OF NORTH DAKOTA.

BISMARCK, N. D.
TRIBUNE, STATE PRINTERS AND BINDERS
1903

STATION STAFF.

J. H. WORST, LL. D.	Director
E. F. LADD, B. S.	Chemist
C. B. WALDRON, B. S.	Horticulturist
H. L. BOLLEY, M. S.	Botanist
J. H. SHEPPERD, M. S. A.	Agriculturist
A. M. TEN EYCK, M. S.	Assistant Agriculturist
T. R. MANNS, B. S.	Assistant Botanist
R. S. NORTHROP, B. S.	Assistant Horticulturist
H. M. ASH	Foreman in Agricultural Department
C. A. BALDWIN	Foreman Horticultural Department
HERMAN CROFT	Herdsman
J. JESSEN	Assistant Herdsman
C. E. NUGENT	Secretary

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LETTER OF TRANSMITTAL.

AGRICULTURAL COLLEGE, N. D.,
February 1, 1903.

HON. FRANK WHITE,
Governor of the State of North Dakota:

SIR: As required by act of congress approved March 2, 1887, and section 945, Revised Codes of 1899, I hereby submit the Thirteenth Annual Report of the North Dakota Experiment Station, for the year ending Feb. 1, 1903, together with a financial statement of receipts and disbursements as required by law, for the government fiscal year ending June 30, 1902.

Very respectfully yours,
W. H. ROBINSON,
President Board of Trustees.

REPORT

To the Board of Trustees of the North Dakota Agricultural College and Experiment Station:

GENTLEMEN: I have the honor to submit to you the Thirteenth Annual Report of the North Dakota Government Agricultural Experiment Station.

During the past year the weather conditions have been favorable for experimentation and the results of experiments made and other investigations, as outlined in this report by the heads of the several departments, contain much that is interesting and instructive. As, during former years, the experiments have been largely devoted to crop rotation, seed breeding and seed selection, methods of cultivation, conservation of moisture, and the cultivation of fruits, berries and vegetables. Planting trees for shelter belts and to produce forest conditions and growing hedges for shelter and for ornamental purposes, also has received considerable attention. The results have been very gratifying. Analysis of foods has largely engaged the attention of the department of chemistry.

The following bulletins were published during the year:

No. 51—Corn Culture.

No. 52—The Length of the Growing Season in North Dakota.

No. 53—Food Products and Their Adulteration.

No. 54— I. Abortion in Cattle.
II. Scours in New Born Calves.

The work planned for the coming year will not differ materially from that of former years, except that more attention will be given to stock feeding and diseases of grain with a view to their eradication—especially flax wilt.

Since the Twelfth Annual Report was published, farmers' institutes were held at Oberon, Carrington, Cooperstown, Wimbledon, Fingal, LaMoure, Tower City, Hillsboro, Sheldon, LaMoure, Ellendale, Hankinson, Forman, Fessenden, Donnybrook, Jamestown, Rolla, Cando, Towner, Leeds, Lakota, Grafton and Finley.

These institutes were conducted by T. A. Hoverstad, of the Minnesota Sub-Experiment Station at Crookston, assisted by M. F. Greeley, editor of the Dakota Farmer, published at Aberdeen, S. D., and John Armstrong, of De Smet, South Dakota, and E. G. Schollander, of the North Dakota Experiment Station. At several of the

institutes held during the year members of the station staff rendered assistance. Mr. Armstrong, who was a valuable assistant, died during the institute season.

The demand for farmers' institutes continues and is far beyond the ability of the institute board to fill, with the present meager appropriation for that purpose. Not less than $5,000 per year should be appropriated by the legislative assembly for farmers' institutes, and a farmers' club or agricultural society should be organized in every county with assurance of having an institute at least once a year, at state expense.

A very strong sentiment is growing up throughout the Red river valley in favor of diversified farming and many farmers who formerly devoted all their energies and land to growing wheat have already added live stock and dairying to their farming operations.

Another condition has lately developed. The immense area of the state lying west of the Red river valley now settled up by farmers, presents many new problems for investigation by the Experiment Station staff. The soil and agricultural conditions of this vast territory, now occupied by small farm holdings, differs so radically from the soil and the agricultural conditions of the Red river valley where the Experiment Station is situated, that a line of experiments should be begun at the earliest moment to meet these conditions. I would suggest that the Sub-Experiment Station at Edgeley, LaMoure county, be fully equipped and extensively operated for this purpose. The range country also requires attention. From overstocking and other causes the grass is rapidly disappearing from many ranges and extensive experiments should be made with a view of renewing the grasses or of introducing new varieties of hardy grasses and forage crops. I would suggest that a grass trial station be located in the range country where such experiments may be conducted.

Improved strains of thoroughbred stock are also badly needed at the Experiment Station for breeding purposes and for giving instruction to the classes in animal husbandry. An assistant should also be employed in the department of dairying to enable that department to inspect the dairy herds of the state for the purpose of assisting dairymen to weed out unprofitable cows and for substituting dairy stock of proper type and quality to make that indusry more profitable.

I would also call your attention to the fact that all departments of the Experiment Station are in need of additional help to enable them to do more effective work and to meet the demands made upon the station. As the Experiment Station is a co-operative institution receiving $15,000 annually from the federal government, the time has come when the state should fully co-operate by providing an annual appropriation equal to that of the federal government. The thousands of recent settlers taking up claims in the western portion

of the state can only prosper by intelligently adapting their labors to their new conditions—conditions that can only be undestood oft-times after expensive experimentation. These new settlers are entitled to the best aid and advice the Experiment Station can give them. It becomes a question, therefore, not whether the state can afford to make this appropriation, but can it afford not to make it?

Agriculture is our chief—almost exclusive source of wealth production—so that whatever fosters and improves it returns to the state many fold what it costs.

J. H. Worst,
Director.

CHEMICAL DEPARTMENT.

To J. H. Worst, Director:

SIR: The present, the Thirteenth Annual Report, covers briefly the work of the chemical department in the Experiment Station for the year 1902.

Hampered as the department has been for laboratory room suited for carrying on lines of research work, it has made it impossible to undertake lines of study that should long ago have received attention.

I trust that a building for housing the department will be provided during 1903, and that an additional assistant can be assigned to this department in order that I may be relieved of much of the routine college work and that I be given an opportunity for doing more experimental work. It is necessary that this department co-operate largely with other departments. Field crops in the agricultural department need to be analyzed to determine their chemical composition. Seed selected for particular purposes all need to be analyzed to determine what progress is being made. If corn is selected for high protein chemical analysis can only determine what progress is being made after the crop has been grown. The feeding stuffs need to be analyzed to find their composition for any comparative study that is undertaken with them. It is believed that wheat can be selected and bred for high gluten content but chemical analysis is necessary to determine what progress is being made.

We hope during the coming year to be able to prepare a bulletin showing the chemical composition of the animal foods—grains, grasses, clover, etc., both the cultivated and wild plants of the state. To do this work it is necessary that better facilities for work be furnished the department.

I do not know of another Experiment Station Department of Chemistry in this country so poorly housed and provided for doing work, as our own, and this, too, in one of the states almost purely agricultural.

Soil investigations have been continued and considerable progress made in the studies undertaken.

A considerable amount of time has also been devoted to an examination of the food products offered for sale in North Dakota, the results of our study have been published as a bulletin, a summary

of which is incorporated with this report. As shown in this bulletin 100 per cent of the jellies, jams, preserves, catsups and soups were adulterated with chemical preservatives or coal tar dyes, of the corns and succotashes 88 per cent, of canned peas 50 per cent, of canned tomatoes 40 per cent, and of canned pork and beans 83 per cent. The above alone shows the necessity of further work in this direction and it is to be hoped that some legislative provision may be made for checking the sale of food products containing such powerful chemical preservatives.

The amount of correspondence during the past year has very largely increased. The total correspondence has amounted to nearly seven hundred (700) letters for the year 1902.

There should also be a law enacted regulating the sale of commermercial fertilizers in the state. True, very little is likely to be sold in the immidiate future but the attempted sale during the past season of a worthless product in carload lots was probably prevented by information from this department. A good law would prevent the probability of such recurrence in the future.

SUMMARRIES OF TEMPERATURE—RAINFALL AND SUNSHINE.

Below are given the summaries by months of the daily meteorological observations made during the past year. The data for preceeding years will be found in previous reports of this station.

TEMPERATURES AND RAINFALL—1902.

Months	Means	Maximus	Minimus	Rainfall, Inches
January	9.4	41	—40	.18
February	14.6	49	—24	.34
March	30.6	57	—13	1.42
April	39.8	72	12	2.30
May	55.3	85	28	4.25
June	58.2	88	31	3.07
July	67.8	94	42	2.54
August	63.7	88	32	2.95
September	54.0	90	19	.58
October	44.6	78	12	5.17
November	27.8	55	0	.19
December	7.2	35	—31	.17
Means and total	39.4	..	....	23.16

The rainfall has been 2.54 inches above the average for eleven years past, and 2.52 inches less than for 1901, which was the year of maximum rainfall since our records began with 1892. The October rainfall was unusually large and gave a large store of water for the ground to carry over another season.

By years the rainfall has been recorded in the following table beginning with 1892:

	1892	1893	1894	1895	1896	1897
Rainfall, inches	20.73	16.17	18.72	16.05	21.77	22.50

	1898	1899	1900	1901	1902
Rainfall, inches	16.36	21.20	25.54	25.68	23.16

This gives an annual average rainfall for the past eleven years of 20.62 inches. The lowest annual rainfall for this period was 16.05 inches in 1895 and the greatest annual rainfall was 25.68 inches in 1901.

The following table shows the amount of rainfall by months for each of several years. From this the variation can easily be seen at a glance.

RAINFALL BY MONTHS.

	1895	1896	1897	1898	1899	1900	1901	1902
January	.36	1.90	.35	.06	.29	.45	.05	.18
February	.12	.06	.77	.10	.29	.54	.11	.34
March	0	.48	.96	.34	1.58	1.23	1.31	1.42
April	1.36	3.64	.89	.88	1.39	1.82	1.76	2.30
May	1.62	4.70	.74	4.15	4.22	.81	.98	4.25
June	4.81	2.41	7.10	2.25	3.44	2.11	5.91	3.07
July	3.24	.91	8.24	2.59	2.78	3.91	7.29	2.54
August	1.59	2.17	.77	2.84	3.71	8.28	1.59	2.95
September	1.55	2.58	.57	1.23	1.24	3.27	2.57	.58
October	.14	1.96	1.81	1.62	1.67	2.80	3.83	5.17
November	1.16	.70	.25	.08	.27	.20	0	.19
December	.10	.26	.04	.22	.33	.12	.28	.17
Summary	16.05	21.77	22.50	16.36	21.21	25.54	25.68	23.16

To show on how many days rain fell each month the accompanying table is prepared. Only those days on which measurable quantities fell are recorded in this table.

NUMBER OF DAYS ON WHICH RAIN FELL.

	1895	1896	1897	1898	1899	1900	1901	1902
January	3	5	2	2	6	5	1	2
February	3	2	1	1	10	7	2	3
March	0	6	3	1	12	7	4	7
April	9	9	4	2	7	5	6	0
May	13	23	7	6	11	3	5	16
June	17	14	14	9	12	9	19	10
July	15	8	12	12	10	10	9	8
August	11	7	2	10	9	13	5	13
September	8	8	3	7	4	15	4	7
October	2	8	10	11	5	6	9	8
November	7	7	2	3	2	6	0	3
December	1	1	1	3	5	2	4	1

AVERAGE RAINFALL FOR NORTH DAKOTA.

One of the questions most frequently asked by new comers to the state is regarding the amount of rainfall for different parts of the state. To answer this question I have compiled from the Report of the Weather Bureau at Bismarck, the monthly record for all parts of the state where there is a complete record for the past ten years.

AVERAGE ANNUAL RAINFALL FOR PAST TEN YEARS.

Station	County	Average Rainfall, Inches
Ashley	LaMoure	17.602
Berlin	LaMoure	19.544
Dickinson	Stark	14.081
Ellendale	Dickey	17.268
Fargo	Cass	20.341
Grafton	Walsh	18.254
Jamestown	Stutsman	20.755
Milton	Cavalier	20.988
Napoleon	Logan	20.171
Power	Richland	19.799
Grand Forks	Grand Forks	21.731
Wahpeton	Richland	24.010
Willow City	Bottineau	16.350
Woodbridge	Cavalier	15.555
Fort Yates	Morton	16.205
Bismarck	Burleigh	15.439
Williston	Williams	15.977
Average for the state	....	18.500

THE FOLLOWING TABLE SHOWS THE AVERAGE RAINFALL BY MONTHS FOR THE PAST TEN YEARS EXPRESSED IN INCHES.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total Monthly Average
Ashley	.730	.532	1.398	2.118	1.913	3.831	2.330	2.086	.694	1.090	.510	.370	1.466
Berlin	.497	.930	1.350	2.343	1.670	3.825	2.914	2.526	1.167	1.272	.834	.585	1.659
Dickinson	.481	.510	.928	1.591	1.927	2.250	2.380	1.280	.764	.760	.650	.560	1.173
Ellendale	.570	.580	1.405	2.080	1.610	2.990	2.540	2.183	1.070	1.060	.830	.330	1.439
Fargo	.381	.246	.990	1.904	2.449	3.981	3.690	2.880	1.690	1.690	.520	1.920	1.695
Grafton	.602	.661	.742	1.918	1.930	3.430	1.990	2.320	2.380	1.105	.806	.370	1.521
Jamestown	.460	.630	1.040	2.080	2.650	4.300	2.56.	2.410	1.880	1.005	1.050	.690	1.729
Milton	.569	.550	.871	2.700	2.650	3.800	3.270	2.300	2.220	1.030	.690	.338	1.749
Napoleon	.734	.609	1.096	2.182	2.099	4.591	2.590	2.460	1.099	1.200	.999	.502	1.697
Power	.470	.560	.930	2.060	1.770	3.790	3.830	2.330	1.450	1.620	.610	.359	1.648
Grand Forks	.540	.469	.621	2.803	2.588	5.850	2.130	2.280	1.700	1.480	.790	.500	1.810
Wahpeton	.460	.560	1.580	2.540	2.630	4.280	4.240	3.470	1.750	1.740	.510	.250	2.000
Willow City	.420	.466	.660	1.540	1.880	3.350	2.390	1.490	2.070	1.160	.620	.310	1.360
Woodbridge	.345	.265	.430	1.[illegible]69	1.444	3.470	2.490	1.560	2.080	.868	.564	.370	1.296
Ft. Yates	.660	.480	.161	2.349	1.715	3.570	1.517	2.920	1.530	1.050	.743	.410	1.350
Bismarck	.463	.389	1.180	1.680	1.890	3.390	1.400	1.410	1.360	1.010	.821	.446	1.286
Williston	.732	.514	1.020	1.430	2.370	2.650	2.030	.986	.914	.777	.910	.644	1.331
Average for state	.536	.526	.921	2.058	2.068	3.785	2.697	2.118	1.550	1.183	.732	.527	1.553

MONTHLY RECORD OF SUNSHINE.

The hours of sunshine as recorded in the following table are the data as recorded by a Friez photographic sunshine recorder. No correction has been made for early morning and evening sunshine, which is not recorded by this photographic method. The recorded sunshine should probably be increased about 12 to 15 per cent to make the hours of actual sunshine.

SUNSHINE RECORDED—1902.

Month	Total Hours		Hours Daily Mean		Percentage of Possible Sun-Shine
	Possible	Recorded	Possible	Recorded	
January	279.9	122.9	9.00	3.96	44.4
February	287.1	131.1	10.30	4.70	46.0
March	370.0	124.1	11.90	4.00	36.7
April	407.3	206.2	13.50	6.90	51.3
May	466.3	226.1	15.00	7.30	48.6
June	475.0	237.7	15.80	7.90	49.6
July	480.2	290.5	15.46	9.40	60.5
August	441.8	206.6	14.23	6.66	46.9
September	378.3	194.6	12.60	6.48	51.4
October	336.6	142.7	10.89	4.60	43.0
November	281.6	81.4	9.40	2.70	29.3
December	267.1	85.9	8.60	2.80	32.1
Total or Means	4,470.2	2,034.8	12.24	5.61	45.2

In the following table are shown the percentage of the actual sunshine of months for the past four years.

PER CENT OF SUNSHINE BY MONTHS.

	1899	1900	1901	1902
January	31.3	37.8	40.0	44.4
February	51.9	50.0	50.2	46.0
March	55.5	44.9	48.9	36.7
April	61.6	65.8	42.7	51.3
May	39.1	68.2	64.8	48.6
June	52.2	55.1	40.4	49.6
July	63.7	56.1	53.5	60.5
August	42.8	36.4	57.9	46.9
September	58.7	38.9	55.8	51.4
October	29.4	31.2	57.7	43.0
November	39.3	36.6	42.8	29.3
December	47.7	30.2	22.3	32.1
Mean	48.8	47.1	49.43	45.2

The data for 1902 show a slightly lower average of sunshine than for the preceeding years.

The total hours of recorded sunshine and percentages of possible sunshine for the past four years are shown as follows:

	1899	1900	1906	1902
Total hours recorded......	2,166.85	2,116.5	2,203.7	2,034.8
Daily mean hours recorded.	5.97	5.70	6.05	5.61
Percentage of sunshine....	48.8	47.1	49.43	45.2

The following table shows the approximate number of hours of sunshine possible for each day during the year at Fargo:

APPROXIMATE HOURS OF POSSIBLE SUNSHINE AT FARGO.

Day.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1....	8.6	9.6	11.1	12.8	14.4	15.7	15.8	14.9	13.4	11.7	10.0	8.8
2................	8.6	9.6	11.1	12.8	14.4	15.7	15.8	14.9	13.4	11.7	10.0	8.8
3................	8.6	9.7	11.2	12.9	14.5	15.7	15.8	14.8	13.3	11.6	9.9	8.8
4.	8.6	9.7	11.2	12.9	14.5	15.7	15.8	14.8	13.3	11.6	9.9	8.8
5................	8.7	9.8	11.3	13.0	14.6	15.8	15.8	14.7	13.2	11.5	9.8	8.8
6................	8.7	9.8	11.3	13.0	14.6	15.8	15.8	14.7	13.2	11.5	9.8	8.8
7................	8.7	9.9	11.4	13.1	14.7	15.8	15.8	64.7	13.1	11.4	9.7	8.7
8................	8.7	9.9	11.5	13.2	14.7	15.8	15.8	14.6	13.0	11.3	9.7	8.7
9................	8.7	10.0	11.6	13.3	14.8	15.8	15.8	14.6	12.9	11.2	9.6	8.7
10................	8.7	10.0	11.6	13.3	14.8	15.8	15.8	14.6	12.9	11.2	9.6	8.7
11................	8.8	10.1	11.7	13.4	14.9	15.9	15.7	14.5	12.8	11.1	9.5	8.6
12................	8.8	10.1	11.7	13.4	14.9	15.9	15.7	14.5	12.8	31.1	9.5	8.6
13................	8.9	10.2	11.8	13.5	14.9	15.9	15.7	14.4	12.7	11.0	9.4	8.6
14................	8.9	10.2	11.8	13.5	15.0	15.9	15.6	14.4	12.7	11.0	9.4	8.6
15................	9.0	10.3	11.9	13.6	15.0	15.9	15.6	14.3	12.6	10.9	9.3	8.6
16................	9.0	10.3	11.9	13.6	15.1	15.9	15.6	14.3	12.5	10.9	9.3	8.6
17................	9.0	10.4	12.0	13.7	15.1	15.9	15.5	14.2	12.5	10.8	9.3	8.6
18................	9.1	10.4	12.0	13.7	15.2	15.9	15.5	14.2	12.4	10.7	9.2	8.6
19................	9.1	10.5	12.1	13.8	15.2	15.9	15.5	14.1	12.4	40.6	9.2	8.6
20................	9.1	10.5	12.1	13.8	15.2	15.9	15.5	14.1	12.4	10.6	9.2	8.6
21................	9.2	10.6	12.2	13.9	15.3	15.9	15.4	14.0	12.3	10.6	9.1	8.5
22................	9.2	10.6	12.2	13.9	15.3	15.9	15.4	14.0	12.3	10.6	9.1	8.5
23................	9.2	10.7	12.3	14.0	15.4	15.9	15.3	13.9	12.2	10.5	9.1	8.5
24................	9.2	10.7	12.3	14.0	15.4	15.9	15.3	13.9	12.2	10.5	9.1	8.5
25................	9.3	10.8	12.4	14.1	15.4	15.8	15.2	13.8	12.1	10.4	9.0	8.5
26................	9.4	10.8	12.4	14.1	15.4	15.8	15.1	15.8	12.1	10.4	9.0	8.5
27................	9.4	10.9	12.5	14.2	15.5	15.8	15.0	13.7	12.0	10.3	9.0	8.5
28................	9.4	11.0	12.5	14.2	15.5	15.8	15.0	13.7	11.9	10.3	9.0	8.5
29................	9.4	....	12.6	14.3	15.5	15.8	14.9	13.6	11.9	10.2	9.0	8.5
30................	9.4	....	12.6	14.3	15.5	15.8	14.9	13.6	11.8	10.2	8.9	8.5
31................	9.5	....	12.7	....	15.6	....	14.9	13.5	....	19.1	....	8.5
Total hours..	279.1	287.1	369.0	407.3	456.3	475.0	480.2	441.8	378.3	337.6	281.6	267.1

The next table has been completed to show the number of days each month on which no sunshine was recorded.

NUMBER OF DAYS WITH NO RECORDED SUNSHINE.

	1899	1900	1901	1902
January	5	9	4	7
February	5	2	3	6
March	4	7	4	8
April	3	2	7	2
May	5	0	3	5
June	2	2	3	2
July	0	1	1	1
August	2	6	3	1
September	0	8	3	4
October	6	13	4	7
November	9	11	5	12
December	5	11	15	12
Total	46	72	55	67

This gives an average of sixty days during the past four years on which no sunshine was recorded, or 16.4 per cent.

EVAPORATION FROM A WATER SURFACE.

It is interesting to know the rate of water evaporation from a water surface during the summer months and in connection with soil experiments this determination was made. A galvanized iron tank three feet square by fourteen inches in depth painted black contained a second smaller tank 12 by 12 by 12 inches in dimensions likewise blackened. These were sunk in a grass plot level with the surface of the ground. The small tank contained distilled water and this tank within the larger was surrounded with water. Daily measurements were made of the amount of evaporation and the results by months are given in the following table expressed in inches.

The table showing the amount of water evaporated daily, expressed in inches:

Date	May	June	July	August	September
1	.21	.32	.10	.0	.20
2	.03	.10	.20	.08	.30
3	.14	.20	.40	.30	.01
4	.64	.03	.31	.40	.20
5	.02	.74	.38	.29	.30
6	.88	.10	.40	.25	.30
7	.23	.10	.23	.25	.30
8	.15	.20	.10	.25	.13
9	.05	.40	.20	.10	.20
10	.0	.15	.20	.37	.30
11	.07	.05	.30	.02	.10
12	.10	.30	.20	.25	.20
13	.10	.51	.40	.10	.20
14	.40	.25	.25	.50	.20
15	.14	.15	.15	.10	.10
16	.0	.21	.30	.10	.02
17	.99	.25	.10	.30	.23
18	.0	.25	.20	.28	.19
19	.81	.10	.10	.25	.17
20	.30	.18	.0	.10	.0
21	.41	.10	.0	.26	.0
22	.15	.10	.0	.04	.02
23	.13	.0	.0	.11	.01
24	.18	.01	.0	.16	.02
25	.0	.10	.0	.51	.30
26	.15	.0	.0	.32	.0
27	.20	.15	.0	.25	.10
28	.0	.30	.0	.17	.20
29	.0	.18	.15	.10	.30
30	.0	.12	.07	.11	.0
31	.0		.23	.20	
Total Mean	6.48	5.75	4.77	6.62	4.50
Daily Mean	.202	.192	.154	.213	.150

The total amount of water evaporated from a water surface for the five months, May to September inclusive, was 28.12 inches, or an average of 5.624 inches per month, or a daily average of .183 inches. The total rainfall for the same period of time was by months as follows:

May	4.25
June	3.97
July	2.54
August	2.95
September	.61
Total	14.32

This is but little more than one-half as much as the water evaporation for the same period, or an average of 2.864 inches per month, or an average daily rainfall of .0936 inches as compared with an evaporation of .183 inches per day.

COARSE FEEDS.

Analyses were made of several samples of feeding stuffs used for roughage as follows:

No. 1—Barnyard grass cured as hay.
No. 2—German millet, cut early.
No. 3—German millet hay, nearly ripe.
No. 4—Pigeon grass, nearly ripe.
No. 5—Red clover hay, in bloom.
No. 6—Timothy hay, in dough.
No. 7—Brome grass, in purple.

In each case the analysis is for the water free substance.

	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7
Ash	11.34	11.89	11.23	9.74	14.22	6.79	8.43
Fat	1.84	3.11	2.15	2.94	3.79	3.36	4.91
Crude fibre	36.06	31.21	33.04	33.09	26.84	29.70	30.40
Proteids	7.00	7.63	7.31	6.13	13.75	8.19	11.80
Nitrogen—free extract	43.76	46.16	46.27	49.10	41.40	51.96	45.18
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

The high per cent of proteids in brome grass brings its food value up towards that of average clover hay.

CORN FODDER.

Analyses have been made of corn fodders from the crop of 1901 planted at different thickness. The following description applies to the method of growing crop.

No. 1—Corn grown in drills 44 inches apart and the hills from 2 to 3 feet apart in drills.

No. 2—Corn grown in drills 42 inches apart and stalks 10 inches apart in drills.

No. 3—Corn grown in drills 30 inches apart 6 inches in rows.

No. 4—Sown in drills 6 inches apart.

	No 1	No. 2	No. 3	No. 4
Water	15.77	22.03	17.75	22.33
Ash	4.94	5.69	4.79	4.61
Fat	2.43	2.44	3.55	2.71
Crude Fibre	23.07	22.67	21.52	21.61
Proteids	7.00	6.14	6.99	6.79
Nitrogen Free Extract	46.79	41.03	45.40	41.95
Total	100.00	100.00	100.00	100.00

It will be observed that No. 1 contains the greatest per cent of both proteids and nitrogen free extract, the two food products having greatest food value.

CORN PLANTED ON DIFFERENT DATES.

In 1901 corn was grown in drills 6 inches apart also in drills 44 inches apart, planted on different dates and all cut at the same date, just before the killing frost.

The analyses are for the water free substance. Corn planted in drills 6 inches apart.

	Planted June 8	Planted June 15	Planted June 22	Planted July 2
Ash	8.12	8.84	8.26	12.91
Fat	3.20	3.80	3.73	2.73
Crude Fibre	29.12	28.66	30.45	31.24
Proteids	7.19	8.19	9.50	10.06
Nitrogen Free Extract	52.30	50.51	48.06	43.06
Total	100.00	100.00	100.00	100.00

Corn of same variety grown in drills 42 inches apart gave results as follows:

	Planted June 8	Planted June 22	Planted July 2
Ash	7.03	7.40	11.42
Fat	5.30	3.20	2.77
Crude Fibre	27.80	28.48	32.94
Proteids	8.69	9.19	10.90
Nitrogen Free Extract	51.18	51.73	41.97
Total	100.00	100.00	100.00

This data can only be used comparatively since the yield per acre was not determined.

Again, I question whether there would not be differences in the character and feeding value of the several lots of nitrogen free extract. Here is a field of work which should be more fully investigated and a more thorough and complete analysis made of the character of the proteids and carbohydrates before we can estimate the true food values of the several lots.

MILLET SEED.

A few varieties of millet seed were analyzed and the results are given in the following tables:

No. 647—Barnyard millet seed.
No. 854—Hungarian millet seed.
No. 769—New Siberian millet seed.
No. 857—Hog millet seed.
No. 708—German millet seed.

	No. 647	No. 854	No. 769	No. 857	No. 708
Water	11.59	10.86	9.55	9.07	10.29
Ash	4.24	3.51	3.17	4.43	3.62
Fat	5.67	4.95	4.29	4.03	4.41
Crude Fibre	7.56	8.53	7.59	8.70	8.70
Proteids	10.61	12.09	10.57	10.35	11.16
Nitrogen—Free Extract	60.33	60.06	64.85	63.42	61.82
Total	100.00	100.00	100.00	100.00	100.00

From the above it will be seen that the Hungarian millet seed (854) contained rather more of proteids than either of the other varieties. Professor Shepperd has shown that the average yield of millet seed for three years at this station has been 2,053 pounds, or as compared* with other grains for the same period the yield was as follows:

	Average yield per acre in pounds.
Millet	2053
Emmer (Speltz)	1829
Oats	1809
Barley	1717
Wheat	1556

Of a few of the varieties the yield for 1901 according to the same authority was

	Pounds per acre
New Siberian	1965
Hungarian	1720
Hog	1450

*Twelfth Annual Report of the North Dakota Experiment Station, page 67.

From the above data it will be readily seen that the amount of food furnished by millet seed is very great. There is offered here a good field for further experiment.

A few other grains were analyzed; all from the crop of 1901, and the results will be of interest in comparison with the millets.

No. 1—Emmer or speltz seed.
No. 2—Mansury barley.
No. 3—Northwestern dent corn.
No. 4—American white banner oats.
No. 5—For comparison I give the average of the five analysis of millet seeds analyzed and reported in the previous tables.

	No. 1	No. 2	No. 3	No. 4	No. 5
Water	4.36	8.50	9.00	9.26	10.27
Ash	4.61	3.05	1.56	3.58	3.79
Fat	2.17	2.54	4.59	4.46	4.67
Crude Fibre	9.54	6.41	2.57	12.26	8.21
Proteids	12.81	12.10	10.44	12.56	10.95
Nitrogen—Free Extract	66.51	67.40	71.84	57.88	52.11
Total	100.00	100.00	100.00	100.00	100.00

In bulletin No. 39 from this department we gave the analysis of the unhulled emmer or speltz, of the hulled grain, and of the hulls. We reproduce the results there presented for comparison. It has been found that the hulls constitute about 20 per cent of the entire grain of emmer.

	Emmer not Hulled	Hulls from Emmer	Hulled Grain
Water	8.88	4.62	10.03
Ash	4.33	13.58	1.84
Fat	2.55	1.64	2.80
Crude Fibre	10.09	36.68	2.94
Proteids	9.81	2.81	11.69
Nitrogen—Free Extract	64.34	40.67	70.70
Total	100.00	100.00	100.00

The hulled grain would contain about the same amount of nutritive matter as the sample of corn, while the unhulled grain would have less of food material than barley, and presumably would be less digestive from the hard husks covering the kernel.

FEEDING STUFFS.

The following description applies to various feed stuffs grown on the college farm in 1902, the analysis of which follow after the description. The stuffs are from the field experiments under Professor Ten Eyck, who also furnished the samples for laboratory analysis.

300. Millet and oats 1½ pecks of the former and 6 of the oats planted June 17th and harvested August 26th. Millet nearly ripe and oats in bloom, yield per acre 4,901 pounds of dry matter.

301. Barley 6 pecks and oats 6 pecks per acre of seed planted June 17th and harvested August 26th. The barley was then in hard dough and the oats in bloom, yield 4,401 pounds of dry matter.

302. North Dakota emmer seed at rate of 11 pecks per acre on June 17th, harvested August 26th, seed in early milk and the yield 4,590 pounds dry matter per acre.

303. Yellow Canadian field peas seed at rate of 10 pecks per acre, planted June 17th and harvested August 26th, in blossom and pods, yield 4,313 pounds dry matter.

304. White Russian oats seed at rate of 12 pecks per acre June 17th and harvested when seed was in milk September 5th. Yield 4,471 pounds dry matter per acre.

305. Sample of Lupine grass peas.

306. Field peas seeded at rate of 4 pecks per acre and oats at rate of 8 pecks on June 17th, harvested September 5th, the peas being hard and oats in milk. The yield was 4,895 pounds dry matter.

307. Mansury barley seeded June 17th at rate of 10 pecks, harvested with seed in milk stage August 15th, yield of dry matter 3,417 pounds per acre.

308. German millet seed 3 pecks per acre June 17th and cut when fully headed August 15th with a yield of 4,076 pounds per acre.

309. Japanese barnyard millet.

310. Corn on fall plowing, planted with a lister

311.

312. Corn on spring plowing planted June 10th, harvested September 17th, planted in drills 6 inches apart. The yield of dry matter was 4,260 pounds per acre.

313. Corn on fall plowing, planted June 10th and harvested September 17th with corn in silk and milk. The yield was 1,843 pounds of dry matter planted in drills 42 inches apart.

	300	301	302	303	304	305	306	307	308
Water	11.40	9.56	9.68	10.88	11.24	9.23	11.07	10.02	8.63
Ash	8.05	6.63	8.54	4.99	8.12	4.98	7.91	6.12	8.35
Fat	2.09	2.10	2.13	1.95	3.48	2.05	3.20	2.52	2.63
Crude fibre	31.11	27.17	30.43	24.24	27.56	34.50	29.00	19.24	30.14
Proteids	8.12	9.56	9.73	14.54	9.26	12.62	10.85	10.93	10.93
Nitrogen—free ext.	39.23	44.98	39.49	43.41	40.34	36.62	37.97	51.17	39.32
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

The following are for the water free substance:

	309	310	311	312	313
Ash	11.07	6.71	6.09	5.05	5.63
Fat	2.07	2.08	2.48	2.60	2.53
Crude fibre	32.62	27.85	22.34	25.44	24.97
Proteids	5.37	11.69	9.13	10.50	9.12
Nitrogen—free extract	48.87	51.67	59.96	56.11	57.75
Total	100.00	100.00	100.00	100.00	100.00

WHEATS.

Analysis of a few varieties of wheat crop of 1901 were made the data for which is presented below:

No. 1—Minnesota wheat, No. 163.
No. 2—Macaroni wheat (Kubanka).
No. 3—Rystings fife wheat.
No. 4—Bolton's blue stem wheat.

	1	2	3	4
Water	7.85	16.50	10.28	9.27
Ash	2.15	2.18	1.94	2.04
Fat	2.14	2.65	2.76	2.34
Crude Fibre	2.33	2.45	2.45	2.50
Proteids	20.31	18.94	17.25	16.63
Nitrogen—Free Extracts	65.22	57.28	65.32	67.22
Total	100.00	100.00	100.00	100.00
Gliadin	9.13	8.00	7.00	7.75
Glutenin	5.69	5.81	5.06	4.38
Gluten	14.82	13.81	12.06	12.13

Very few of the wheats for 1901 were plump, but more or less shriveled which may account in part for the relatively per cent of proteids. It will be noted, however, that the Minnesota No. 163, leads the rest in high proteids and gluten as well. The analysis of one sample of flour produced in a local mill from a sample of Aronatka or macaroni wheat will be of interest and is given below.

	Per cent.
Water	5.02
Ash	.85
Fat	2.16
Crude Fibre	.74
Proteids N x 6.25	15.69
Nitrogen—Free Extract	75.54
Total	100.00
Gliadin	7.31
Glutenin	4.69
Glutin	12.00

In this sample the gliadin constituted 6 per cent of the total gluten and the gluten was 77 per cent of the total proteids.

SELECTING WHEATS FOR HIGH PROTEIDS AND GLUTEN.

In 1900 this department in co-operation with Professor Shepperd began the selecting of wheats and making analysis of the kernels to determine to what extent the seed would propagate its fixed properties from year to year. This work has continued for three years now and the results of the experiments are brought together in tabular form for more convenient comparison. The letters A. B. C. etc., represent the number of heads found in each stool. About one-half of the seed in each head was used for purpose of analysis and the other portion saved for seed to be planted the following year. It might be said that the higher results for 1901 are probably due to the fact of dry weather at the later stage of ripening and the shriveling of the grain before fully matured. In 1902 the very wet, cold season gives a lower per cent of proteids than for the dryer season of 1900. We make no discussion at this time, but place the data on record and will continue the experiment for a series of years, gradually eliminating the less promising heads or stools of grain.

The following table gives the per cent of nitrogen and the proteids or albuminoids found in the grain for each head of wheat.

Several varieties of wheat are included in these experiments. Stools, 55, 5 and 34 were one variety; stools 65, 58, 46, 12 were the same variety, and stools 36, 79, 15, 6 were of one variety; while stools 55b, 158b, 2 were alike, also stools 98, 75, 48 and 9. If by this process of selecting we can secure a wheat with 18 to 20 per

cent of proteids and with a relatively high gluten that will propagate its properties certainly it would be of great value to the wheat growers of North Dakota. Experiments indicate that we may hope to secure such results by selecting.

Stool	Head	Nitrogen			Albuminoids or proteids		
		1900	1901	1902	1900	1901	1902
55	A B C	2.91 2.75 3.14	3.27 3.93 3.33	2.47 2.47	18.19 17.19 19.63	20.43 24.56 20.81	15.44 15.44 .....
	Average,	2.93	3.51	2.47	18.33	21.93	15.44
5	A B C	3.07 2.71 2.84	3.63 3.35 4.60	2.84 2.60 2.48	19.18 16.94 18.06	22.68 20.93 28.75	17.75 16.25 15.50
	Average,	2.89	3.86	2.64	18.06	24.11	16.50
34	A B C D	2.90 2.86 2.68 2 53	3.91 3.12 .... 3.54	2.60 2.55 2.69 2.51	18.13 17.82 16.75 15.81	24.43 20.44 ..... 22.13	16.25 15.94 16.81 15.69
	Average,	2.74	3 52	2.58	17.12	22.33	16.17
65	A B C	2.10 2.86 2.09	3.55 3.64 3.64	2.30 2.45 2.83	13.13 17.82 13.16	22.19 22.74 22.74	14.37 15.31 17.68
	Average,	2.35	3.61	2.52	14.70	22.55	15.78
58	A B C D	2.56 2.97 2.19 2.98	3.33 3.37 3.26 3.22	2.57 3.03 2.68 2.99	16.00 18.56 13.69 18.63	20.81 21.06 20.37 20.13	16.07 18.94 16.75 18.68
	Average,	2.67	3.29	2.81	16.72	20.59	17.61
46	A B C	2.89 2.89 2.87	3.10 3.09 3.19	2.71 2.57 2.53	18.06 18.06 17.94	19.37 19.31 19.93	16.93 16.06 15.81
	Average,	2.88	3.12	2.60	18.02	19.53	16.26
12	A B C D	.... 2.82 2.96 2.70	3.36 2.71 3.29 3.41	2.76 2.59 2.76 2.33	..... 17.63 18.50 16.88	21.00 16.94 20.56 21.31	17.25 16.19 17.25 14.56
	Average,	2.82	3.19	2.61	17.67	19.95	16.31

ANALYSIS TABLE—Continued.

Stool	Head	Nitrogen			Albuminoids or proteids		
		1900	1901	1902	1900	1901	1902
36	A B C D	2.42 2.42 2.85 3.05	3.78 4.24 3.44 3.44	2.76 2.82 2.84 2.68	15.13 15.13 17.81 19.06	23.62 26.50 21.50 21.50	17.25 17.65 17.75 16.75
	Average,	2.68	3.72	2.77	16.78	23.28	17.35
79	A B C D	2.52 2.85 2.95 2.50	3.38 3.69 3.50 3.39	2.58 2.70 3.12 2.68	15.75 17.81 12.19 15.63	21.13 23.04 21.87 21.18	16.12 16.87 19.50 16.75
	Average,	2.45	3.49	2.77	15.34	21.80	17.31
15	A B C D	2.23 2.54 2.54 2.34	3 18 3.66 3.55 3.65	2.41 2.73 3.12 2.85	13.94 15.85 15.88 14.63	19.87 22.87 22.19 22.81	15.06 17.06 19.50 17.81
	Average,	2.41	3.51	2.77	15.07	21.93	17.35
6	A B C D E	3.20 3.47 2.70 2.66 2.63	3.36 3.67 3.61 3.38 3.30	2.61 2.37 2.84 2.51	20.13 21.68 16.87 16.62 16.44	20.99 22.94 22.56 21.13 20.63	16.31 14.81 17.75 15.68 ....
	Average,	....	....	....	18.35	21.65	16.14
68	A B C	2.75 2.38 2.72	3.25 3.56 3.22	2.93 2.73 1.86	17.18 14.88 17.00	20.31 22.25 20.13	18.31 17.06 11.63
	Average,	2.61	3.34	2.50	16.25	20.89	15.66

No discussion will be given until the work has been continued through a series of years and the crop grown in quantity.

CORNS SELECTED FOR HIGH PROTEIDS.

From the crop of 1901 Mr. Schollander selected by physical examination, several samples of corn for high proteid content. This corn was selected as seed for 1902 planting and below are given the per cent of proteids in the selected corn, also in the crop grown from the same in 1902. In the last two columns are given the per cent of true proteids as determined by the phospho-tungstic method and by Stutzers cupric hydrate method. In each case the results are the average for three determinations.

Selected Ear No.		Per Cent Total Proteids		Albuminoids or True Proteids in Crop 1902	
		Crop 1901	Crop 1902	Phospho-Tungstic Method	Stutzer's Method
1		13.88	......	......	....
2		11.56	......	......	....
3		14.00	14.00	13.44	13.24
4		13.13	14.00	13.44	13.37
5		13.44	14.00	13.77	14.25
6		13.00	13.25	12.68	13.06
7		14.31	13.12	13.23	13.23
8		12.81	......	......	....
9		14.31	14.00	13.00	13.23
10		13.88	14.87	13.06	13.06
11		15.44	15.44	14.87	15.12
12		12.69	......	......	....
13		12.56	......	......	....
14		11.94	......	......	....
15		15.31	14.31	13.81	13.87
16		13.69	14.00	13.08	13.62
17		14.31	13.63	13.30	13.49
18		13.31	14.00	13.30	13.56
19		12.44	......	......	....
20		11.81	......	......	....
21		10.06	......	......	....
22		13.56	14.00	14.00	13.77
23		12.56	......	......	....
24		13.13	15.75	15.00	14.87
25		13.13	12.93	12.75	13.67
26		13.56	14.68	14.25	14.66

The results show the corns selected for high nitrogen content in 1901 have produced in nearly all cases corn of high nitrogen content in 1902. While the averages for 1902 are somewhat lower than for the seed of 1901, this can probably be explained by the conditions of the growing season of 1902, which has been exceptionally poor for corn.

The first column given shows to what extent it is possible to select corn by the physical method for high nitrogen. In but a few instances was there any mistake.

BAT GUANO.

A sample labeled bat guano was sent in by Gage & Davis, of Amenia, to ascertain its value as a fertilizer. An analysis showed it to have the following per cent of fertilizing constituents:

	Per cent.
Sand	34.96
Nitrogen	.55
Total phosphoric acid P2O5	1.54
Potash K2O	1.10

This is evidently some refuse product with almost no value as a fertilizer.

A good fertilizer law would prevent the possibility of such stuff being offered for sale in this state and farmers from being defrauded by purchasing a worthless article.

ADULTERATED FOODS.

Bulletin No. 53, dealing with food products and their adulteration was prepared and published from the chemical department and some of the statements and data contained therein are presented herewith.

It has been found that nearly all of the jellies, jams and preserves examined, such as strawberry, currant, raspberry, orange, pear, etc., consist largely of other fruit jelly, mainly apple, artificially flavored, containing preservatives and often colored in imitation of the real product. Some of the jellies, etc., examined, we are confident, do not contain a trace of the fruit they claim to be and as given on the label. A blackberry jelly was found to be starch paste sweetened, colored with coal tar dyes to imitate blackberry, preserved with formalin and sulphurous acid and artificially flavored.

Of the 33 samples of jams, jellies and preserves, not one was free from chemical preservatives and in some instances at least three distinct classes of preservatives were present in the same sample. It will be noticed also that the adulterations are not confined to the cheap grade of goods, but are to be found in the best and highest grade products on the markets, in the products of firms of the highest standing in the commercial world and who claim absolute purity for their goods. The question then may be fairly asked whether they are sending to this state their better grade of goods or whether inferior products are being used for North Dakota trade?

Of the eight samples of catsups examined, all contained coal tar dyes to give color, and seven of the eight contained chemical preservatives, and numbers 23 and 99 contained unnecessarily excessive amounts to act as preservatives could not but prove harmful to those consuming the products. While it is difficult to distinguish between tomato and certain other vegetable products in some samples, I am confident that other products were used, as for example pumpkin pulp to help give consistency to the mass. The full results are pre-

sented in the following table, and it will be observed that No. 171 contains three well known chemical preservatives, and in the case of No. 99 a brand labeled "Superior Tomato," a very inferior compound product, the name of the producer is not given. In this there was present a large amount of coal tar color, a small amount of formalin and an excessive amount of salicylic acid, but in spite of the preservatives and coloring matter the contents of the bottle were very dark and in bad condition.

Of the five samples of soup examined four contained preservatives and the one free from preservatives contained coal tar dye, so that all were found adulterated.

Of the nine samples of corn and succotash examined five were sweetened with saccharin, the coal tar sugar. In some instances where the sweetening was employed the corn was an inferior product.

Of the five samples of pork and beans examined five contained chemical preservatives. Of ten samples of lemon extract examined three were found pure and of good strength; two were found pure, but of very low strength, and five were found to be wholly artificial. Out of ten samples of vanilla extract three were found pure and seven artificial or lacking in strength. Candies, cream tartars and spices were found to be adulterated to a considerable extent.

The following table gives a summary of the number of samples examined, number found pure and per cent found to be adulterated:

	No. Examined	No. Pure	No. Adulterated	Per Cent Adulterated
Jellies, preserves, etc	33	0	33	100
Catsups (bottled)	8	0	8	100
Soups (canned)	5	0	5	100
Canned corn and succotash	9	1	8	88
Canned peas	12	6	6	50
Canned tomatoes	10	6	4	40
Canned pork and beans	6	1	5	83
Lemon extract	10	3	7	70
Vanilla extract	10	3	7	70
Candies	28	14	14	50
Cream tartar	5	3	2	40
Spices	49	21	28	57
Totals and averages	186	58	128	70

That is 70 per cent of the above food products as offered for sale in Fargo were found to be adulterated.

The following general statement closes this bulletin:

"The data presented in this bulletin plainly indicates that law to prevent food adulteration is not being complied with on the part of the producers whose goods are being sold in this state.

"The law should be so amended as to make it the duty of some officer to inspect the food products offered for sale in this state. When food products are found to be adulterated and after due warning to those not complying with the law all parties found violating it should be prosecuted by the state's attorney of the district on proper certification of the facts by the inspecting officer. This work could be most economically done if made a part of the work of the Government Experiment Station, as is now the case in many of the other states.

"The writer believes it little less than criminal that food products should be allowed to be sold in the state containing such large quantities of chemical preservatives and coal tar dyes, as have been found in some of the canned goods, catsups and preserves.

"From preliminary examinations it is believed that many food products not given in the following lists will be found to contain equally as large amount of chemical preservatives.

"From examinations of vinegars sent to the writer for analysis from various parts of the state, it would seem that but very little of the produce being sold as cider vinegar was really made from apples.

"Samples of milk and cream sold in the state have been found to contain formaldehyde. As already shown milk containing formaldehyde certainly can not be a safe food for infants and invalids. The use of formaldehyde is wholly unnecessary for preserving milk and any person using it for that purpose should be punished to the full limit of the law."

NEEDS AND ACKNOWLEDGEMENTS.

Adele Shepperd has served as assistant in the station laboratory for the past year and a great deal of the routine work has been performed by her. Mr. L. B. Greene served as laboratory assistant until July 1st, when he resigned to take up the study of medicine at Michigan university. At the same date Mr. Hugh McGuigan returned from one year leave of absence and has since divided his time between station duties and college work. I desire to commend the faithful work of each of these assistants to whom the department is under many personal obligations.

The one great need of the department at the present time is for rooms where chemical work can be expeditiously and safely performed without being disturbed by college exercises. The present quarters, poorly ventilated, overcrowded, improperly heated and often damp beneath the floor, are a menace to the health of all engaged in station laboratory work.

Respectfully submitted,

E. E. LADD,

Chemist.

DEPARTMENT OF BOTANY.

To Director J. H. Worst:

SIR: The work of this department in the laboratories has been considerably interrupted during the past season because of difficulties in getting settled in the new quarters in Science hall. Only the types of laboratory work which could be carried out amid some confusion, or those which demanded immediate attention have been undertaken. The field work, also, has been limited to the study of the flax crop and its diseases. The investigations of the two previous years upon the wilt disease of flax indicated it to be a matter of such great economic importance that almost the entire time of the department has been given to this subject. Some preliminary experiments along certain lines which give promise of future importance have, as usual, been undertaken. It is ,of course, in such way that one first locates and estimates the value of any particular study, its possibilities, and the methods to be followed. The studies upon flax, at first, gave very slight promise, but now, after two years of more definite effort, it proves to be one of the most important and difficult farm problems yet undertaken.

ROTATION PLANS TO PURIFY FLAX-SICK SOILS.—After determining that the cause of the wilt disease of flax is to be attributed to a parasitic fungus which can exist for some years in the soil, it was quickly seen that, even though it were possible to prevent further introduction of the flax wilt fungi into the soils of the state, it becomes a matter of much importance to study the effects of crop rotation upon the development of the parasite in the soil. Plot No. 30, a piece of thoroughly infected college land was therefore set apart for this special study. It has been divided into twelve beds for the purpose of special studies upon crop rotation, and records are being kept upon the results. The crops planted in 1901 were as follows: Bed 1, fallow; 2, wheat; 3, potatoes; 4, beets; 5, bare fallow; 6, oats; 7, oats; 8, salt, 20 pounds and fallow; 9, sulphur, 20 pounds and fallow; 10, flax; 11, sowed corn; 12, idle. Results, good crops upon all of the beds except bed 10, where the flax practically all died before three inches in height.

The crops which were planted on the beds in 1902 were as follows: Bed 1, corn; 2, corn; 3, brome grass; 4, beets; 5, peas, field plan; 6, bare fallow; 7, corn; 8, salt, 20 pounds and flax, the seed of which has been treated to destroy any disease spores which they might bear; 9, sulphur, 20 pounds and flax, treated as in bed 8; 10, flax, treated and untreated seed, two portions of the bed; 11,

sowed corn; 12, idle. Results, good crops upon beds 1, 2, 3, 4, 5 and 7. No. 12 has thoroughly grown up to numerous wild prairie plants, perennials. Nos. 8 and 9 produced a fine growth of flax which practically all died of wilt disease before three inches high. The flax on No. 10 also wilted, as usual, with the exception of a few scattering plants.

In conducting this work much effort is made to keep from transferring diseased dirt, etc. from bed to bed. All of the work of preparing the soil for seed is done by hand labor. There is no indication that the disease attacks other crops or plants than flax. There is also as yet no indication of improvement in the beds, that is, the Fusarium which produces the disease is still there. For fnrther details as to this work see Sixth Biennial Report of the College and Experiment Station and Bulletin No. 50.

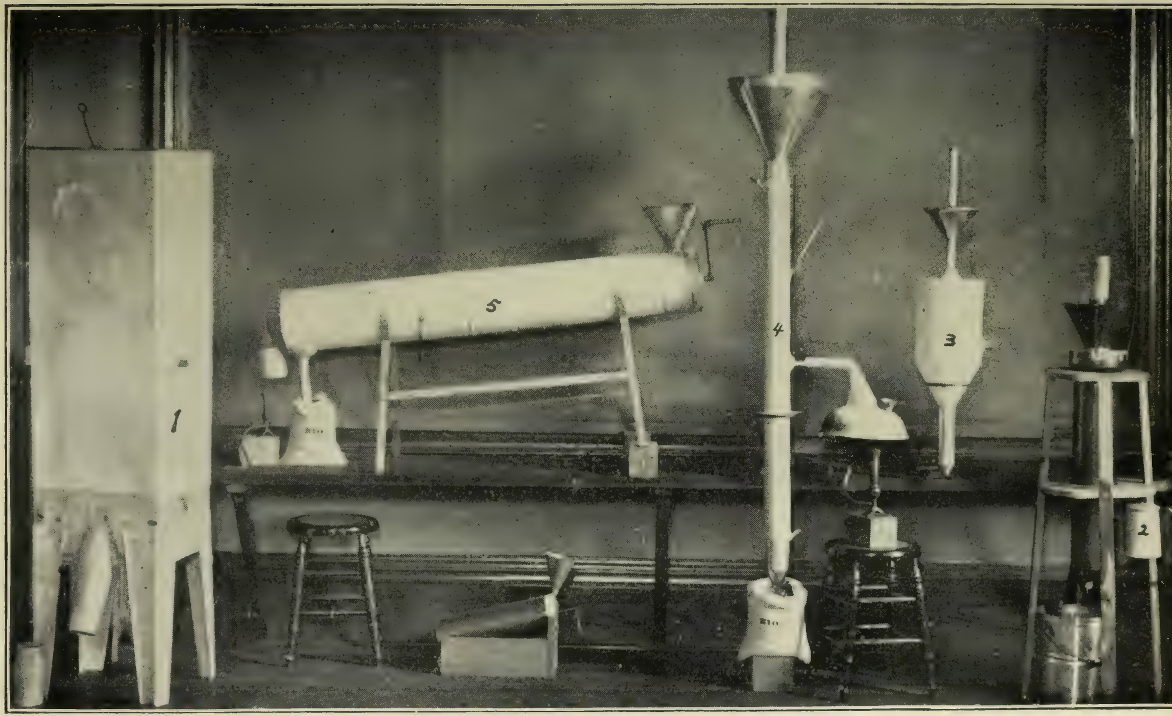
Detection of the Presence of Wilt Disease in Seed and Soil—It will readily been seen that, as the fungus which causes this wilt disease of flax is microscopic in form, it is of the greatest importance to be able to detect its presence in the soil or in seed grain. Considerable effort has been made to accomplish this result. It has been found that, by means of the ordinary physician's centrifuge, one can readily detect its presence in the seed. A large number of seed samples from all parts of the state, and from several counties in Minnesota, have been examined. It is found that the disease is very generally distributed ,fully eighty per cent of the number of samples examined being found infected. This teaches that farmers ought not to rely upon unknown flax for seed purposes. One ought to grow his own seed. See Bulletin No. 50 upon this point. The spores of the wilt organism have also been detected in flax seed from the following foreign countries: Argentine Republic, Japan, Austria, Holland, Russia and Belgium. The spores of a species of Colletotrichium which we have found to be parasitic on flax, is also gen eral in its distribution.

In our efforts to determine the proper series of crop rotations, an ability to analyze soils so as to show the comparative fungus content under different crop culture would prove of much value. To this end extensive laboratory experiments are being conducted. These give fair promise of results. The beds on infected plot No. 30 are being tested for the presence of the wilt fungus at different depths, different periods of growing season, etc. To date, these cultural tests have been made quite successfully for depths varying from two to five inches. The tables of results show that numerous species of fungi and bacteria are present in the soil, and that several kinds are quite constant in the different beds regardless of the fact that the different beds have borne different sorts of field crops as corn, peas, beets, potatoes, etc. With reference to the flax wilt organism, it is instructive to know that, August 1st, it was found in the soil samples of each of the beds. This is the second season since

flax was last grown there excepting in the case of No. 10, in which flax is seeded each year. This line ef laboratory culture and analyses will be continued until we have complete records of the life history and habits of the organism in the soil and until something more definite concerning the effects of cultivation and cropping methods upon its development has been obtained. It is very probable that the life of the wilt producing fungi in soil, in the absence of the flax crop, will be found to be most lasting in the more fertile, heavy lands of the state. There are, however, many other conditions which may effect different results.

Crop Rotation—As yet, we are unable to give any directions concerning the process of rotation other than to say that the only precedent to follow is that set by general practice in the flax growing countries of Europe. There, seven year between flax crops is the least period usually recommended. In this connection Professor F. Schindler, of the Agricultural and Polytechnic Institute at Riga, Russia, in a personal letter, sent through the kindness of the honorable United States vice consul at Riga, says: "The disease does not seem to be known in the Baltic flax districts where flax crops are made to alternate with crops of other domestic plants in such a way that the same soil is only allowed to produce flax every six years, an interval which, in most cases, is even extended to nine or twelve years." Among foreign growers of flax, opinion differs much as to which series of crops proves to be the most beneficial for rotation work after flax, but most writers seem to be agreed that deep methods of cultivation and grassing prove especially beneficial, while certain other crops such as red clover are especially favorable to the increase of the effects of the disease. They differ so much, however, in these matters that we shall have to work the question of crop rotation out upon our own lines with crops suited to our conditions. From the studies which we have made upon the life of the parasite under special trials, the indications are very favorable to a rotation which shall contain our chief crops in about the following order : (1) Flax, (2) wheat, oats or barley, (3) corn or other cultivated crops or fallow, (4) wheat, (5) grass, (6) grass, (7) pasture, (8) flax. A thoroughly cultivated fallow will certainly prove beneficial in the series, and corn will, I think, prove equally beneficial. If, eventually, it is proved that the wilt fungi can attack other of our cultivated crops than the flax or that the continued development of the organism in the soil, then the rotation series will certainly have to be made to conform.

The Development of a Continuous Process for Treating Flax Seed with Formaldehyde Vapor or Gas—Having learned that the fungus which is the cause of flax-sick soil is distributed upon new fields by means of flax seed, a treatment which would destroy the spores was at once sought. As flax seed easily gums when wet, a steam or dry treatment, it is easily understood, would be



Cut No. 1. Represents a photograph of some experimental models of machines used for the purpose of treating flax seed with formaldehyde vapors. The most desirable working forms are represented by the two types numbered 4 and 5 respectively.

desirable. Much work has been done to determine the proper form in which to use formaldehyde gas, the strength of solution to evaporate, the proper form of machine in which to effect the treatment, etc. This work involved the study of many germination tests, and valuable data have been secured.

Two types of machines have been found to give effective results, and the tests in the field give assurance that this mode of seed treatment can be perfected. It was found that every type of machine constructed and every modification of the conditions under which it is used demanded a different handling of the gas as to rate of evolution, strength of solution for evaporation, etc. Machine No. 5 of cut No. 1 was planned by Professor Keene, of the mechanical department of this institution and uses a solution for evaporation, in strength, of approximately ¼ per cent to 1 per cent commercial formaldehyde. Machine No. 4 represents the most satisfactory form of the erect type of machine and demands a strength of 1 per cent to 3 per cent formaldehyde solution for evaporation. These machines are only in the experimental stage of construction and are shown here merely as matters of interest to those who may contemplate the construction of a seed disinfection machine for commercial purposes. Good results have been gained in experiments with each of the types shown, and the capacity is sufficient in each case, for ordinary field purposes.

The general conclusions drawn from the work with these trial machines may be stated as follows:

1. Flax seed may be disinfected without injury to its growth qualities by means of vapors from evaporating formaldehyde.

2. It is necessary that the gas shall be associated with a large body of water vapor. It is not effective in the dry form.

3. Different forms of machines demand different strengths of formaldehyde for evaporation.

4. The effectiveness of any particular machine and the strength of solution which is most effective for it can only be determined by a series of germination and field tests.

The trial machines used in these preliminary tests may be roughly described as follows: Machine No. 1 is simply a hollow galvanized tank 16x16x48 inches, covered with asbestos, fitted with hopper and with five internal slanted shelves for scattering the grain as it falls. It proved to be on too extensive a plan for our experiments, and was discarded early because too powerful a condenser of vapor in proportion to the work done. To our surprise we were unable to produce sufficient vapor for its capacity, which is also far beyond the needs of ordinary farm work.

This machine shows that a small apparatus with large steam capacity is the thing to be desired. The ones numbered 2, 3 and 4 respectively represent further attempts to reach the desired results by simply dropping the grain through the vapor. No. 2 is a crude

affair made of tile to avoid excessive condensation, but does not well effect that end; Nos. 3 and 4 have both been used through a long range of preliminary tests, and give every promise of successful operation. The same evaporator, that is seen attached to machine No. 4, has been used to produce the vapor for all tests and for all of the machines.

In the case of the erect machines an attempt is made to bring the cold, falling, but scattered, grain in direct contact with live steam from the evaporator, the thought being that an even film of condensed formaldehyde will thus form about each seed as it falls. To accomplish a thorough spreading of the grain, small cones are swung at intervals throughout the course of the fall. Machine No. 4 is simply a three-inch tin tube covered with asbestos and fitted with a feed regulator by which the number of bushels fed per hour may be fixed, thermometer fittings, collars for varying the outflow, etc.

Machine No. 5 is a hollow cylinder, 8 inches by 5 feet, with a revolving gauze cylinder which conveys the grain downward from the hopper. Its chief merit is that it allows one to regulate the time of exposure to a nicety by varying the inclination of the cylinder. The strength of solution which can be used varies with the inclination and speed of revolution, which factors determine the time of exposure. A large number of treatments have also been made with this machine, and they give promise of furnishing an effective range for the treatment of the wilt disease of flax.

A very large number of flax samples have been treated in the different machines to determine the range of germination resistance of flax seed, and the effect upon the propagation of wilt diseases. Germination tests have been made upon all, in pans and in sterile dirt and numerous plots have been grown upon virgin sod in the field in competition with the standard formaldehyde, copper sulphate, and corrosive sublimate liquid treatments. The range of treatment, so far as effect upon seed germination and crop production is concerned, may already be quite certainly fixed for each type of machine, and the type of evaporator which was used. The capacity of a machine depends not so much upon its size as upon the amount of vapor produced. Thus the actual capacity of machine No. 4 is approximately one hundred bushels of flax per hour, but in our experiments we were unable to reach a capacity exceeding fifteen bushels per hour, which was considered effective, because the limit of the evaporator, used, was reached at or below that point. In all cases the grain was bagged direct from the machines, and to our surprise the gas does not make it unpleasant to conduct the work, as the cold, falling grain at once condenses practically all of the fumes. As it is bagged it may be set aside where the work of completing the treatment is probably better perfected than in the machines. The death point of free spores may also be fixed by our record. This was in part

determined by study of spores put through the machines upon bits of paper with the grain, and in part by separating them from the treated grain by meains of the centrifuge. Dead ones of Fusarium and of Colletotrichium are easily known by inspection or through culture trials.

As shown by the conditions of seed germination, the maximum strength of formaldehyde solution to be used in evaporation for the three most perfect of the machines is about as follows:

For machine No. 3 working at a rate of about five bushels per hour, and in temperature of 55 degrees C the strength of solution may be about 7 to 10 per cent on the commercial standard.

Machine No. 4 working at the rate of seven to twelve bushels of grain per hour and at a temperature of 45 degrees C, will stand vapor from 1 to 3 per cent commercial standard, while for machine No. 5 the strength of solution which may be applied without injury at 50 degrees C and a 20-second exposure is approximately ¼ per cent commercial strength.

Treatment Experiments With Flax Seed for Prevention of Soil Infection—It is hoped that the farming public will quickly realize the necessity of sowing only perfectly formed, disinfected flax seed. The fungus which causes the wilt disease of flax is not present in our native soils. Let every farmer, then, make all possible effort to avoid infecting any more soil areas. After doing the best possible, some disease will perhaps creep in, but we have found that it can be reduced to a minimum. This year extensive experiments were conducted under such conditions that we are able to judge of the effectiveness of the various forms of treatment which we have undertaken. These have been first applied in laboratory tests, then later in the field upon a field basis of work. In all, 120 field experiments were finished, and the following treatments were given careful attention: (1) The corrosive sublimate treatment. Strengths of solution ranging from 1-10 part in 1,000 to 5 parts in 1,000 of water were used. (2) The copper sulphate treatment. Treatments were made using solutions made at the rate of one pound in five gallons of water, one pound in four gallons of water, and one pound to three gallons of water. (3) The Formaldehyde treatment. This solution was used in various strengths ranging from ½ part in 1,000 of water to 7 parts in 1000. The three methods of treatment are all accomplished by what may be termed the "sprinkling or spraying" method. (4) The gas treatments were also given a good trial under field conditions.

All of these different methods of seed treatment gave good results in the field; and we are now able to tell how to use each of the four types of substances. Observations upon the effect of the different treatments upon the seed germination powers, upon the resulting growth of flax throughout the season, and upon the development of wilt in the different samples treated are very interesting, but the

tabulated observations and data are too extended to be used here. Only a few representative numbers will be given, simply to indicate the general results obtained.

All samples were planted on same date, upon evenly prepared soil in the same drill, the drill being thoroughly cleaned after each, and set to sow three pecks per acre. The soil upon which the seeds were planted was virgin sod for the first 72 plots and for the following 48 plots it was on land which, though old, had never previously grown flax.

Tests of the Corrosive Sublimate Solution.

Experiment 1. Magill sample No. 3—4 parts corrosive sublimate in water.

Germination in Geneva pans, 65.

Germination in dirt, 82.

In the field the growth at first seemed a little slow, later the stand appeared thinner than check, but stronger. Seed leaf spot was present from start and some plants wilted during the season.

Final crop, 368 plants on one rod from one shoe of the drill, with one wilted plant.

Weight of dry straw and grain matured on 47 feet from five shoes of the drill, 11 pounds, 13 ounces.

Exp. 4. Same sample—2½ parts of corrosive sublimate in 1000 of water.

Germination in Geneva pans, 96.

Germination in dirt, 89.

Stand in field strong from the start; seed leaf spot and some wilted plants died early.

Final crop matured, 562 plants in one rod from one shoe of drill, with five wilted plants present.

Weight of dry straw and grain from 47 feet from five shoes of the drill, 12 pounds, 10 ounces.

Exp. No. 8. Same sample—½ part corrosive sublimate in 1000 parts of water.

Germination in Geneva pans, 99.

Germination in dirt, 98.

Stand always very fine but apparently more wilted plants than in experiments of stronger treatment.

Final crop, 626 plants in one rod from one drill or shoe and eight wilted plants.

Weight of dry straw and grain from 47 feet from five shoes of the drill, 13 pounds, 3½ ounces.

Exp. 12. Small immature or light seed, screened from Magill sample No. 3—untreated.

Germination in Geneva pans, 84.

Germination in soil, 76.

Stand from start thin, poor, weak plants; many died of wilt throughout the year.

Crop matured, 217 plants with 12 dead of wilt on one rod from one shoe of the drill.

Weight of crop on 47 feet from five shoes of the drill, straw and grain, 8 pounds. 2 ounces.

Exp. 14. Magill sample—untreated.

Germination in Geneva pans, 90.

Germination in dirt, 97.

Stand in field from start, poorer than any treated sample; plenty of wilt in clumps all through the season.

Cut No. 2. This figure is taken from a photograph of some samples of flax pulled from the field for the purpose of illustrating some characteristics of the disease known as flax wilt. Figure 1 shows some typically wilted plants, dying just preceding the blossom stage. Figure 2 represents a clump of such plants. The plants for Nos. 1 and 2 were pulled from a badly diseased area of ground upon which diseased flax had grown two previous years. The clump numbered 3 was pulled from a field in which the flax was nearly reaching maturity. It shows the scraggly effect produced by the disease at this stage. The crop from which this bunch of flax was pulled was the second one upon diseased land. The clump of flax plants to the right represents the type of crop which was grown from the same seed used for crop No. 3, but the seed was given the formaldehyde treatment and was sowed upon clean land.

Crops matured, 333 plants per rod from one shoe of the drill, with three nts then dead of wilt.

Total weight of dry straw and grain on 47 feet of five drill rows or shoes of the drill. 12 pounds.

Exp. 16. Magill sample No. 3—formaldehyde solution, 4 parts in 1000.

Germination in dirt, 82.

Stand from start at least equal to check, but not so strong as No. 18 and other slightly weaker treatments. Later the strong treatments made most rapid growth. Some wilt appeared from seed leaf infection.

Final crop matured, 427 in one rod from one shoe of the drill, with no plants showing wilt.

Weight of crop from 47 feet of five drills or shoes, 12 pounds, 1 ounce.

Exp. 18. Same sample—formaldehyde; strength of the solution, 3 parts in 1000 of water.

Germination record in dirt, 86.

Stand in the field, strong plants from the start; some wilt from seed leaf spot from the start.

Crop matured, 531 plants in one rod from one shoe of drill, with three showing wilt.

Weignt of crop matured on 47 feet of five drills or shoes, dry straw and grain, 13 pounds, 10 ounces.

Exp. 57. Formaldehyde vapor from 2½ per cent solution or approximately 1 part to 15 of water. Machine No. 5, temperature 75 degrees to 60 degrees Fahr., exposure 20 seconds, sacked direct from the machine in an open meshed cotton bag.

Germination record slow; in dirt, rather irregular, 80.

Stand in the field, thin from start, and slower by two days than experment No. 18. Treatment too severe; wilt present during season from seed leaves.

Crop matured, 337 plants with one plant wilted, as counted from one rod of a single drill, or shoe of the drill.

Weight of crop from 47 feet of five drills or shoes, 9 pounds, 7 ounces.

Exp. 70. Same sample—same treatment as in experiment 57, but strength of solution used was 10 per cent strength, or approximately, 1 part to 3 of water.

Result, seed practically all destroyed; 14 plants only matured on one rod from one shoe of drill.

Total weight of dry straw and grain on 47 feet of five drills or shoes was 1 pound, 9 ounces.

Exp. 62. Same sample—formaldehyde vapor, from solution of 1 part to 7 of water, or approximately 5 per cent, through the gravity machine No. 3. Temperature, 70 degrees to 65 degrees Fahr.

Germination record, in dirt, about as fast as check; not so strong as in experiment 18. Total, 94.

Straw in field, slow at start, a little weakened. Plants not so strong as those from experiment No. 18. Finally produced an apparently good stand. Wilt appeared. Crop matured, 532 plants on one rod from one shoe of drill, with two dead of wilt.

Weight of dry seed and straw matured on 47 feet of five drllls or shoes, 11 pounds, 1 ounce.

Fxp. 100. Johnson's Minnesota seed, from flax-sick soil—untreated for check on treated samples.

Germination record in Geneva pans, 96.

Good stand but not so many plants at first even as in the better treatments. Wilt present.

Grew thinner from wilt throughout the summer.

By estimation less than two-thirds of a crop.

Matured 285 plants on one rod from one shoe of drill, with one wilted plant.

Exp. 94. Johnson's sample, same as experiment 100, copper sulphate treatment—solution, 1 pound to 3 gallons of water.

Germination record in dirt, 99.

Growth in field, splendid from the start, and the strength of growth remained very much better and stronger than the check throughout the year. A few wilted plants developed from infected seed leaves.

The crop matured 370 plants on one rod of one drill row or shoe, and showed one wilted plant at pulling time.

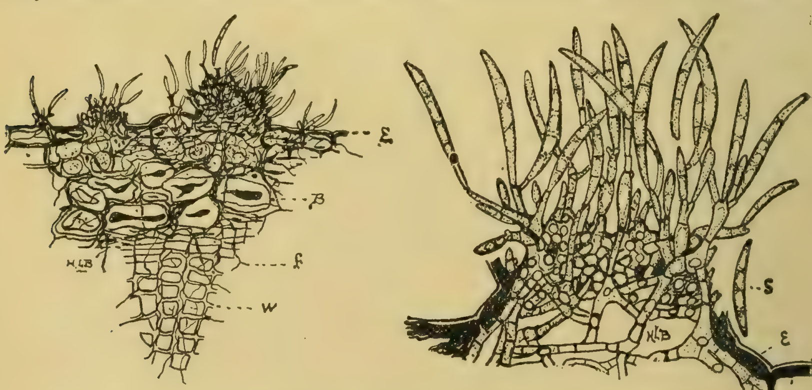
In all cases of treatment in which a solution was applied, a spray pump was used with the nozzle so set that a fine, misty spray was thrown upon the grain as the latter was rapidly raked or handled over, the work being continued, until upon handling, the grain was seen to be thoroughly moist or fogged over the entire surface of each grain. It was then left piled for a time, and it was found, in all cases, when the moisture had been properly applied, not to exceed one-half gallon per bushel, that good, strong, mature flax seed would take up the moisture to such extent that the grain would be practically ready for seeding in from two to three hours. Of course it is always well to stir such damped seed over several times to be sure that it may not heat.

The grain treated by the continuous vapor method was bagged hot from the machine in small bags so that I feel sure that a vapor treatment can be perfected, which will be perfectly safe, if the grain is shoveled over once or twice as it runs from the machine.

The treatments given above are not printed as models, or as representing the best results obtained in seed treatment of flax, but merely to serve as guides, showing the trend of the work.

The treatment which we recommend for farmers will be found in the summary of recommendations.

General Notes and Observations Upon Treatment of Flax Seed for the Prevention of Flax Wilt—(1) It is learned that any method of seed disinfection in which the chemical or substance



Cut 3. Figures showing clumps of spores which the *Fusarium* usually produce upon the sides of mature flax stems. The drawings are made from cross sections of a flax stem, through the spore beds. The figure on the left, in low magnification, indicates how the filaments ramify the tissues: *b*, bast fibers; *w*, wood cells; *f*, fungus filament; *e*, epidermis; *s*, mature spore. The magnification of the figure on the right is approximately 400 diameters.

used is applied in proper form and strength to destroy ordinary fungus spores upon the hulls of flax seed, proves a great benefit to the first growth of young plants from the seeds. Strong flax seeds have their young plants protected from attack, and weak, imperfect and slightly diseased seed in most cases have the fungi which prey upon the young plants killed, thus leaving the young plant to make full use of the food material it may have stored in the seed coat.

(2) Any ordinary disinfectant solution of proper strength, may be used with safety until the gum of the seed coats begins to soften and swell.

(3) By using an ordinary misty spray, such as can be thrown from a finely set, common Bordeau nozzle, one can make use of approximately one-half gallon of solution per bushel of flax seed. This means that in doing the treating the most important portion of the work is to handle the seed flax over rapidly while the fine spray is being applied. Indeed, it pays to stop spraying every now and then and shovel the grain over rapidly, taking about fifteen minutes to treat a pile of five to ten bushels of grain.

(4) Dipping cannot be safely applied. It is found impossible to dry flax which has been dipped in quantity.

(5) The use of lime or other drying agents has not been found to give desirable results. If by accident too much liquid has been applied to a volume of flax, throw in some more dry flax and stir over rapidly.

(6) The vapor treatment of a continuous stream of flax seed will be possible and successful as soon as a machine is perfected which will give an even flow of seed and apply a continuous flow of vapor from the evaporator. Indeed, the entire success of machines such as those represented by our experimental models now depends upon having a type of evaporator of such nature that any one using the machine will know that a constant stream of formaldehyde vapor is being thrown into the machine. This could certainly be accomplished by the production of a small boiler which would automatically discharge its steam and open up the seed valve at the same time, when a given pressure of steam is reached in the evaporator or boiler. That pressure would not need to be great. I here call attention of elevator men and mill men to the desirability of having an attachment in their mills which would allow them to treat seed grain for farmers in their immediate vicinity. It would pay for the process itself and be of much mutual benefit to the farmers and to the companies.

(7) The vapor treatment is a perfect one, for the flax wilt trouble because each cold grain as it falls through the aqueous vapor has condensed about it a complete film of the evaporated liquid.

(8) The strength of solution to be evaporated depends upon the duration of exposure and that depends upon the type of machine used.

(9) In the case of evaporation of formaldehyde solutions by boiling, we have determined that the amount of gas evaporated from a given strength of solution is approximately uniform, and that the solution which is condensed from that vapor holds formaldehyde in approximately the same proportion as the original solution.

(10) It has been found that the conidiospores of the wilt Fusarium, and all similar thin walled (hyaline) spores are easily destroyed by this mode of seed disinfection. It is not the province of this department to enter into the process of manufacturing machines for carrying out such work as this, but we will gladly make tests of any reasonably constructed models to ascertain the value of the same and the strength of formaldehyde or other disinfectant which ought to be used in the work with such machines. Our experimental models are published to indicate possible lines of construction.

(11) The seed treating process cannot be a perfect preventive of flax sick soil, unless exceptional care is taken in the selection of seed. In some samples of diseased seed, the fungus which causes flax wilt, and two or three other types of fungi which attack the flax plant, and are especially destructive to it while the plants are young, actually gain admission to the inside of the seed coats, while the seeds are yet attached to the mother plant. In the case of the regular wilt Fusarium and also a species of fungus known as Colletotrichium, the seed leaves of the embryo are often attacked as soon as formed in the seed. This fact accounts for the peculiar spots on the seed leaves of many young plants which are grown from badly diseased samples of flax seed. The fungus starts to grow as soon as the seed leaves leave the seed coats. Such seed leaves turn yellow and soon die. Such internally diseased seeds produce sick plants, no matter what method of treatment is applied. The fungus inside cannot be killed without killing the embryo and the sound seeds with which these imperfect ones are mixed.

(12) Because of the conditions mentioned under point 11, none of our attempts at seed treatment excepting those in which the most rigid selection of perfect seeds was made, has succeeded in entirely preventing the occurrence of wilted plants.

(13) Each internally infected seed invariably produces a wilted plant some time during the growing season, and each wilted plant starts a new area of soil infection.

(14) We have worked with samples of seed flax which contained as high as 25 to 30 per cent of such internally attacked seeds.

(15) If a sample of flax has been well cured, that is to say properly ripened and saved dry, one can usually recognize internally diseased seeds. They are often imperfectly developed, may have a dark-colored point, or may have a spot or area of improper color showing through the transparent seed coat. In samples of seed in which the disease has been bad, there will always be found many

light weight, dark-colored seeds. Often the seed coats are scaly, or scurfy because attacked before properly matured. The seed coats of such seeds are, probably, in all cases thoroughly infested with one or more types of disease producing fungi, including the wilt fungus.

(16) Proper seed treatment insures the killing of all wilt producing spores which are present on the outside of the seeds, or may be intermixed as dust particles.

(17) The resting spores of the wilt producing fungus are developed in the pith or other open tissues of the stem of the flax plant. This kind of spore is very resistent, and being protected by the tissues of the stem is safe from injury in the ordinary methods of seed treatment. Bits of diseased stem, even in treated samples, start points of soil infection. Bits of chaff or the hulls of the flax bolls may do the same thing.

(18) If a sample of flax seed which contains wilt infected seeds, wilt spores, or wilt infected straw particles becomes wet, the wilt fungus germinates at once, and multiplies in the seed with great rapidity, growing directly into the hulls or coats of the seeds. In those cases in which the fungus gets deeply into the coats, the seeds will produce wilt infection whether treated or not. This is why some samples of flax are such great producers of wilt. It is also the reason, all sufficient, why the farmers should, at once, cease to use seed which has been thrown into elevators. One bad sample of the grain, if slightly damp, soon effects the thorough infection of the whole lot. A number of regions are known, by observation this year, in which the new lands of entire communities were made thoroughly flax-sick by the first seeding because of the use of such damp, infected seed.

(19) It is evident from a consideration of the conditions cited under points 11 to 18 inclusive, that proper seed selection, seed cleaning, curing and grading are first essentials to the prevention of flax-sick soils. Proper selection demands that one should raise his own seed, and that he should select the best possible, cleanest, undiseased,-weed free, part of the field to thresh for this purpose. Proper curing demands that the seed must be harvested when mature, and when dry, threshed when dry and must be kept dry. The presence of many large green weeds in the crop at cutting time is sure to interfere with proper drying. Proper cleaning insures the removal of dust, dirt, straw, chaff, and light weight imperfect seeds, all of which trash may contain the wilt producing fungus. Proper grading leaves only large ,plump seeds. If the color of these is seen to be bright, one can rest assured that after using the formaldehyde treatment, there will be a clean healthy stand of flax, when it is sown upon clean undiseased soil.

(20) No sample of flax seed should be trusted, without treatment. We have been unable to find one which is entirely free from the wilt fungus.

(21) As noted, elsewhere, proper seed treatment greatly improves the first growth from the seed. Our experiments teach that a stronger growth occurs from treated seed throughout the season, regardless as to how strong a quality of seed is used. No untreated sample has given as strong growth and yield as properly treated seed from the same lot.

(22) Selection of seed for wilt resistance: Of the many observations made during these attempts to produce a treatment or preventive for this destructive soil trouble none stand out with such clearness or give such good promise for the future good of the flax growing business as the different proofs we have been able to obtain that there are some strains of flax plants which can resist the disease or diseases which cause flax-sick soil. There is thus much hope that eventually we shall be able to breed strains of flax which will produce good flax upon flax-sick soil. We have been making attempts at selection along these lines since the summer of 1899 and are now able to report some very satisfactory results, which will be given in detail in a bulletin now being prepared. Regarding flax-wilt, it may be said that some samples of "common flax" have been found to be almost wholly without ability to resist the disease. Other samples of "common flax" seed have been found, which contain a comparatively large percentage of seeds which produce resistant plants. We have saved seed from many such plants which allow us to continue observation on this matter. Such plants seem to transmit immunity to the following generation. If this process is found to be a lasting one, we may hope for a final, perfect solution of this trouble.

Summary of the Different Kinds of Treatment and How to Apply Them: *1. The Vapor or Gas Treatment*—This treatment gives great promise of effectiveness and ease of application, but cannot be recommended until a more suitable machine is available and placed upon the market, one which is sure always to give the same results. See note 6, p. 43. Formaldehyde, in vapor form, acts very rapidly and energetically, and unless well applied, acts irregularly and injuriously upon the seed. It is possible that, eventually, this will be the ideal method of seed disinfection for all types of plant diseases which have their inception at the period of seed germination.

2.—The Corrosive Sublimate Method.—As in the case of wheat smut, this substance gives very fine results with flax wilt. It effectually kills all spores with which it comes in contact and exercises a preserving influence under cold, wet soil conditions. It is, perhaps, a more certain spore destroyer than the formaldehyde and, as it is a salt, it remains on the seed coats to protect against future fungus and bacterial action. It does not, however, exercise any appreciable tonic influence upon the after growth from the seed, as seems to be the case with the formaldehyde.

3.—The Copper Sulphate Method.—Copper sulphate has about the same merits as the corrosive sublimate and acts in much the same manner. It seems to be, as is the case with corrosive sublimate, beneficial in preventing decay of the seeds when seeded in cold wet conditions.

4.—The Formaldehyde Solution.—As in the case with wheat and oats, this treatment is found to exercise a beneficial influence on the first growth of the young plants. They come up quicker, grow faster, are stockier in form, have a better color, and produce more than untreated seed, no matter how strong the quality of seed which may be used. It may be used in as strong solution as one pound to twenty-five gallons of water, but, as wilt spores are killed by a weaker solution, properly applied, and as careless applications of the stronger solutions may result in injury to seed germination, I recommend the use of the strength given in the original formula found in bulletin No. 50.

Formulas: (1) Use pulverized corrosive sublimate at the rate of one ounce to five gallons of water. First dissolve the powder in a small amount of hot water then make up to the regular amount. (2) If copper sulphate is used, make a solution by dissolving three pounds of the sulphate to every ten gallons of water. (3) For the formaldehyde solution, use one pound (16 ounces) to forty gallons of water. This must be standard strength, 40 per cent formaldehyde.

Application or Treatment Process: Throw the cleaned, well graded flax seed upon a tight floor, in five or six bushel lots. Apply either one of the solutions through a fine spray. We believe that the formaldehyde solution is the most desirable for general use. Apply the spray slowly in a misty form, shovel, rake or hoe the grain over rapidly and continuously as the solution strikes it. Stop spraying quite often, but continue handling the seed over until about one-half gallon of solution is used for each bushel of seed in the pile. If the work is well done, the grain will not mat together in masses, but will be evenly damp, so that the grains look moist over the entire surface. When thus done, the grain may be piled up and shoveled over once or twice during the next two hours, at the end of which time, the excess moisture will all be absorbed and the grain will be in good condition to run through a drill. A sprinkling pot with a finely perforated nose may be used, but does not give so even results as a fine spray thrown by a small hand pump. Such a pump may be ordered through any hardware dealer. The Bordeaux type of nozzle, which may be set to throw a spray of any degree of fineness, is most desirable for the work.

Caution: Do not allow dampened flax seed to remain piled long enough to begin to heat.

Remember that treatment of seed will not save the crop if the seed is sown upon flax-sick soil, and that to avoid the occurrence of flax-sick soil, the only hope lies in this thoughtful care and treatment of the seed used each year.

THE WORK OF MR. THOMAS MANNS—Much of the detail of the laboratory and of the field work connected with this study of flax wilt, and flax-sick soil has been worked out by the fellowship assistant, Mr. Thomas Manns, and it gives me much pleasure to commend his accurate and painstaking carefulness and ability in carrying out the experiments and tests.

THE WORK WITH FORAGE PLANTS AND FORAGE CONDITIONS—There are many native plants which, because of their forage or weed characteristics, have a direct influence upon the farming and grazing interests of the state. Assistant Botanist L. R. Waldron is applying such of his time, as is not taken up in teaching, upon special studies upon such native plants and upon a study of the forage problems affecting the grazing regions of the state. The numerous cases of cattle poisoning due to the water hemlock indicate that the farmers are not sufficiently familiar with the plant, so common in the sloughs of the eastern part of the state. I, therefore, here embody a short article written by Mr. Waldron upon this subject:

WATER HEMLOCK.

In view of the large number of inquiries received at this station in regard to water hemlock, it was thought desirable to publish some facts regarding it. In this paper the character of the plant, the symptoms of poisoning and the antidotes recommended, are given.

Water hemlock, *Cicuta maculata* is also commonly called cowbane, spotted cowbane, spotted beaver poison, spotted parsley, children's bane and musquash root. It is a smooth perennial, growing each year from three to ten fleshy, tapering roots from three to five inches long and about one-half inch in diameter. Among these are mixed some slender, fibrous roots. The stem is rather stout, hollow, three to six feet high, streaked and spotted with reddish purple. The leaves are doubly compound, that is, each leaf is made up of many leaflets, each one appearing like an individual leaf. The leaves are arranged as shown in figure 4. The small, white flowers are arranged in several flat-topped clusters called umbels, resembling the flowers of a parsnip. A reference to figure 4, which is from a photograph of the plant shows the characteristics enumerated above. It is found throughout the state in wet places, in coulees and along river banks.

A plant, water parsnip, so closely resembles the water hemlock that it will be well to describe it also. It is commonly mistaken for water hemlock, but is said by the best authority to be quite harmless.

Water parsnip, *Sium cicutaefolium,* is a smooth perennial growing each year from a number of fibrous roots which rarely exceed a diameter of one-sixteenth of an inch. The stem is hollow, very stout towards the base, three to six feet high and green. The leaves are compound but *simply pinnate,* that is, the leaflets are arranged in pairs along a main axis similar to those shown in figure 5. The flowers are similar to the water hemlock, but the fruit is smaller

Cut No. 4 represents a photograph of three typical parts of the water hemlock, *Ciutca maculata*, a poisonous plant. Note carefully the shape of the leaf and the tuberous roots.

Cut No. 5 represents a photograph of a typical plant of *Sium cicutaefolia*, a non-poisonous plant which is always associated with the water hemlock. Notice its peculiar shaped leaves and fibrous roots.

and more ribbed. The parts to be noticed in distinguishing the water parsnip from the water hemlock are the *leaves* and *roots.* By reference to the cuts it is seen that the leaves and roots show marked differences and, by these, the two plants may always be distinguished. The roots of the water hemlock in young plants are sometimes apparently fibrous, but they are scarcely ever smaller than a lead pencil and always larger than the roots of the water parsnip. Basing our knowledge upon the plants sent in, other plants besides the two above mentioned are seldom taken for the water hemlock. Both plants are apt to be in one coulee, and it is not safe to conclude that no water hemlock is present if two or three of the plants prove to be water parsnip.

The only means of eradication that can be recommended is to pull or dig the entire plant, including all the roots, pile them where they cannot be molested by stock and when dry, burn.

Poisonous Qualities: The entire water hemlock plant is poisonous, but the roots and especially the green seeds are the most poisonous, although cases are on record of animals having died, when only the foliage had been eaten. The dried plant seems to be less poisonous than the green plant, but the dried seeds and roots may contain enough of the poison to kill. It is evident that hay which contains the hemlock would be less dangerous when fed out of doors, for the seeds would be apt to fall to the ground and thus not be eaten. If the hay be fed in mangers the danger is lessened if they be kept clean, allowing no litter to accumulate, thus getting rid of the seeds. When pasturing on soft ground, it is said that cattle often cut the roots of the hemlock with their hoofs, which allows the surrounding water to be poisoned and when this is drunk poisoning may ensue.

The poisonous quality is due to an alkaloid called conin, which acts as a rapid and powerful paralyzant. I quote from Chestnut & Wilcox (Poisonous Plants of Montana, Bull. 26, Department of Botany, United States Department of Agriculture) a description of the symptoms caused by this poison. "The animals manifested signs of severe pain very quickly after the appearance of the first symptoms. There were also manifestations of great cerebral frenzy accompanied by involuntary muscular movements, which resembled to some extent the movement of animals when suffering from colic. The respiration was labored and somewhat irregular, the pulse was wiry and intermittent. The spasms rapidly become more and more severe as the cerebral excitement increases until the animal appears to be in an unconscious condition and dies in the most violent spasms."

The action of water hemlock is rapid and nearly always fatal, which makes it difficult to treat with antidotes. If the poison symptoms are noticed very early, permanganate of potash and sulphate of aluminum should be given. Equal parts of the permanganate and sulphate are dissolved in enough water so that the medi-

cine should be given as a drench. This may vary from a pint to a quart. The dose for sheep varies from five to ten grains of each kind of salt, for horses fifteen to twenty grains of each kind and for cattle thirty to fifty grains. The salts *must* be entirely dissolved before the medicine is administered and to insure speedy solution the permanganate and sulphate should be finely powdered. The above dose should be followed by morphine given hypodermically, the dose being one and one-half grains for sheep and three to ten grains for horses and cattle. If the poisoning has reached an acute stage, morphine should be given at once and the permanganate omitted. A quantity of melted lard may be given which tends to prevent the absorbtion of the poison and hastens its passage through the alimentary tract. The above measures will prove of value only when a moderate quantity of the poison has been taken, for if much of the plant has been eaten it will act so rapidly that all precautions will be useless. In extreme cases death may ensue within fifteen minutes from the first symptoms.

SUMMARY.

1. Water hemlock may be known from its place of growth, leaves and roots.
2. To eradicate, it must be dug up entire and burned.
3. The most poisonous portions are the fruit, *(seeds)* and roots.
4. When feeding, inside, keep the mangers well cleaned.
5. Antitdotes are of value when applied immediately and when the poisoning is not extreme.

Outline of Work with Recommendations—The demands on the department for work and investigation in the various fields of botanical inquiry have increased very materially each year since the establishment of the station. This is but a natural result to be expected. Many people have come into the state during the past few years to whom the farming conditions, especially those for the growth of plants, are very materially different from those under which they have been used to in their former homes. Our people are thus eager to learn from any source that is open to them, a condition which is very conducive to the acceptance of the results of experimental work. They have quite generally accepted much of the information that we have been able to give, and have been free in giving helpful suggestions toward indicating other lines of work which would be helpful to them. This is an ideal relationship and ought to continue, if the department is to grow, as it should do, to keep pace with the wonderful development of the agricultural interests of the state.

Our experiment station started at a particularly favorable time to be of use to its constituents. The state was new. The soil was new, and the people were new to their environment. From a botanical standpoint the native plants are mostly new to the settlers, the crop plants are either different or demand different methods of cul-

ture and care, and, for the most part, are grown on a scale of production much greater than most of the people have previously known. Thus a botanical study which nets only a small advance in knowledge must of necessity result in great economic gain to the state as a whole. In the twelve years that the work has been carried on, it has for the foregoing reasons been possible for this department to inaugurate a number of experiments which have in their results given some very important aid to the farmers of the state. Some of these experiments have been succssful with us because of the fine virgin soil conditions which exist in the state, though when once accomplished, the principles involved have been found to be applicable in other regions and are now practiced as fixed principles of agriculture in many parts of the world.

I recognize the fact that our experiment station funds are, even now, inadequate to meet the demands of the work of experimentation already under way; yet if it may be at all possible to induce the state legislature to see and understand the needs of the station, and to meet them by a sufficient appropriation, I would like to call your attention to some of the needs of this department.

I think it may be said that the department has ,in the twelve years of its existence, accomplished some good things for the state and country at large. At all times, however, the work has been done under the most meagre conditions of equipment and of assistance. Until the present year, there has been no assistance, capable of independent research, and the equipment for many of the more important physiological and pathological lines of work, which have been undertaken, has quite often been wholly inadequate, for one to be able to hope for the best results. As regards assistance, the department is, now, in much the best status it has ever known. This holds good, however, only provided we may be able to hold the present working force. The laboratories and work rooms are also of very satisfactory form and arrangement, being in the new wing of Science hall, which was lately erected. The equipment is, however, still far from being such as to allow one to carry on such experiments as ought to be done there with facility and speed. Again, in this connection, I call your attention to what I believe to be a very important fact, namely, that there are many lines of investigation which, if settled while the soils of the state are yet in a virgin condition, would mean much to the future wealth and well being of the farmers of the state. This is especially true with reference to a proper study of the relationship of certain diseases of plants and of animals to the soil, and of all those special plant problems which directly demand a knowledge of the native plants of the state, as for example, the forage and weed problems. Many questions have their bases among some one or more of the parts or divisions of these or of similar lines of study, and are directly to be answered, if ever, through efficient biological investigations. Now is the time to do

the work of investigation so that the state may not fall prey to many of the agricultural troubles and to the diseases which infest the soils and crops of older regions. Most such are either avoidable or preventable, if understood, before a farming region becomes old or thoroughly infested with disease. Later, one must hunt for a cure and that is, usually, to be had, only, at much expense to all concerned, if it may be had at all. Thus it is the discovery of a new fact or of a new application of an old one affecting the life of one of the common cultivated plants or of that of a disease producing fungus may easily result in such possible change in the practices of farm work as to amount to some hundreds of thousands or even millions of dollars per year to the state, as is well illustrated by the apparently simple discovery that formaldehyde in certain strengths will destroy the spores of smut upon seed grain without injury to the seed.

In the light of present knowledge, it will be quite disastrous for this state, which has such great interests centered in so few lines of agricultural work, if it fails to make provision to place the knowledge available to her farmers and live stock men upon a par with the best.

A discussion of the lines of experimental work now in progress and a consideration of proposed investigations or studies which should be undertaken will, perhaps, best serve as an index of the real needs of the department. These roughly stated are about as follows:

1. The Work with Plant Diseases—In this work one attempts a study of all of the characteristics of a disease with a view of ascertaining its points of distinction from other of the plant troubles, and tries to determine the real agent back of the disease. To do this, many experiments must be carried out and full records must be taken upon every observable feature. The organism of active agent must be found and its direct relationship to the trouble be determined before one can hope for results from any attempts at a remedy. If it be a living organism which is responsible for the disease, then a long series of cultural experiments or tests must be carried out in the laboratories and greenhouses, and under field conditions before one may announce a probable way to avoid the trouble. This is well illustrated by our previous work with some of the diseases of cereal grains and with potatoes and also by that now under way in case of the wilt disease of flax. In such types of experimentation, when one begins to think that the work is nearly finished, most often, it is but begun. The flax-wilt and flax-sick soil troubles are so pressing for solution that our greatest apprehension is that we may not be able to accomplish that which is possible before it is too late for the results to be of full benefit to the farmers of the state. This diseased condition of the soil spreads with such rapidity and does its work with such certainty that it can only be but a matter of a few

years, at most, when general flax growing will become unprofitable, unless some means of certainly avoiding the trouble may soon be found. The studies upon this subject are now being conducted along three main lines: (a) The perfection of methods of seed treatment for the purpose of preventing the introduction of flax parasite into the soil; (b) the study of methods of freeing the soil from the disease after it is once introduced; and (c) plant breeding and selection for the purpose of obtaining strains of flax which shall be immune or resistent to the disease.

In consideration of the fact, that the fungi which cause the wilt disease of flax, after the soil is once infected, spread through the ground of adjacent areas with great rapidity, and in consideration of the more serious fact, that there are many flax growers who have little concern for the future of the industry; and by their careless, wholesale methods are rapidly infecting almost every part of the state, it is evident that a solution of the problem, to be of use, must come soon. This is true because of the nature of the flax industry and because of the extensive methods of cropping in this region. Our farmers have inherited from European countries a belief that the flax crop is a destructive one upon land; thus, when they once notice that the crop begins to fail, they will drop it. When farmers generally cease to grow the crop, many of the industries which should follow naturally upon flax growing will be impossible of development. For example, the tow mills for the production of stock for paper, binding twine, upholstery, etc., would at once fail because of the distances which straw would have to be hauled. The discontinuance of the growth of flax for seed purposes would also sound the death knell of any possible future industries based upon the growth of fiber varieties. If we can hold the present crop upon a healthy basis, the growth of the finest types of fiber for linen and other industrial purposes is only a matter of seed selection, as has already been demonstrated at this station.

The work with flax, of course, represents but one of the fields for the study of plant diseases in which the department should engage. Wheat, potatoes, and other grains and grasses offer equally important problems for consideration which, upon careful study, may be expected to give fine economic return. The potato crop, especially, is open to destruction by injurious fungi which when once implanted in the soil become persistent pests. There is a physiological trouble affecting the wheat crop. It is commonly spoken of by farmers as "blighting of the heads," "sun scald," "blighting by hot winds," etc. These terms do not properly indicate the cause of the trouble. The real cause is probably more specific. The North Dakota Experiment Station should certainly not rest until, so far as specific diseases are concerned, the wheat crop of the state can annually be brought to the fullest fruition. The "blighting" trouble mentioned, I believe, can be mastered in a definite and complete way, but it will take time and

many costly experiments. One can easily see the possible economic value of such a result to the state. It could hardly fall short of several millions of dollars per annum, if a slight change in our regular methods of practice should be found to do away with this most destructive of all wheat troubles. The rust question is also yet an open one and possible of very definite solution, if attacked in the right spirit of investigation. In regard to this disease and the proper method of experimentation to reach an economic solution for the abatement of its destructive effects upon the cereal crops, I have for several years had some very definite ideas. But ideas and talk will never settle the wheat rust question. There must be real biological experiments conducted. As yet, the matter, so far as this type of plant disease is concerned, has only been played with. Some tests should be inaugurated in this state, but should not be undertaken only to waste time by a long drawn out failure. The full working time of one investigator with plenty of labor for aid might be expected to give some good returns from the investigations upon this rust question. But already enough has been done to allow me to assert that the state must spend some considerable experimental time and moneys upon hope, in order that one may reach a point of vantage or outlook from which to view the question.

2. *The Work with Soil Fungi and Bacteria*: The studies in this line are supplementary and preparatory to the proper study of plant diseases. It has but lately become well understood that many of the most destructive parasitic diseases owe much of their capabilities to do harm because of their ability to persist from year to year in the soil. Many of them live there under different conditions in differforms than when acting as parasites on their hosts. The life history is often so varied in character that one is able to follow it to a satisfactory conclusion in but a few of the best known fungus producers of disease. In those cases in which the life history is well known, as for example in the case of stinking smut of wheat and that of the potato rot fungus it has been comparatively easy to devise economic means of combatting the diseases. In the case of many other fungi, however, there is yet much mystery concerning the full life relations especially with reference to soil, water and the common practices of cultivation. A case in point is that of the wheat rust fungus. Numerous unsettled questions remain about it. What is its relation to wild or native plants? What is the full life and significance of each of its four types of known spore forms of which inconceivable numbers are produced on the attacked plants? What physiological character is it in the wheat plant which causes some varieties, strains, and even individuals to be easily attacked while others appear to resist? etc. To get good results in such studies one must follow the regular bateriological methods of investigation all of which take much time and are very exacting as to requirements. It must all be done by trained labor and each field of experimentation is distinct in

its needs. As an example of this type of work the soil of plot 30 on the station farm on which the flax wilt diseases now completely exclude the growth of flax is being analyzed by bacteriological methods througout the different portions of the year to determine especially the relation of the wilt fungi to the soil, upon what they live, in what structural form they persist, how deeply they penetrate, the influence of the different types of soil upon the development and the persistence of these fungi in the soil, etc.; the amount of work necessary to accomplish the separate cultural analysis is so great as to be almost discouraging, but some fine results have already been obtained. For .example, it becomes more certain that there are numerous imperfectly known fungi which have a more or less direct influence on the production of root diseases. At present the following special studies are being made upon the flax wilt producing *Fusarium*, its relation to water, air, soil, cultivation methods and its special relation to other crops on the soil; its resistance to chemical substances and its ability to live in barnyard manures, etc. The study of the manure question is an especially vital one as affecting our knowledge as to how best to handle the barnyard manures to avoid spreading the disease upon the farm. A composting experiment with diseased flax straw and stable manure is now running and analysis will be made to determine the life of the wilt fungi under such conditions.

3. Plant Breeding and Selection for the Purpose of Procuring Hardy and Immune Strains: The work of plant breeding progresses with rapid pace, and we now know that it is actually possible to produce plants which produce in the race or strain the particular qualities which one may desire. With regard to the development of varieties which have high qualities of productiveness much has already been done and many experimenters are at work along these lines. Little, however, has been done towards producing disease resisting varieties. Enough has, nevertheless, been done to make it certain that such types of plants can be bred. The department of agriculture has, in this way, lately reported what appear to be quite successful results in overcoming a very serious soil disease in cotton. That disease is very simliar in character to the flax wilt trouble, and we have during the last two years procured some results in selecting flax for this purpose which indicate that the work is almost sure of success, if followed up with persistence. At another place in this report and in bulletin 5 of this station a part of the detail of this work will be given. In our plans of future investigations this line of work will receive much attention. No means spared which may facilitate the work. In this connection as in my last biennial report, I call your attention to the probability that much would be gained by sending a special agent to the oldest flax growing regions of the old world to make a careful study of the crop there, especially with reference to the selection of varieties and strains of

flax seed upon which to carry on the attempts of procuring immune varieties. Since writing that report I have made a thorough inquiry regarding the occurrence of the wilt diseases of flax and have authentic confirmation of the occurrence of the wilt disease in one or other of the two forms in which we know it here, in Argentine Republic, South America, Japan, Russia, Austria, Holland, Belgium and in France. I am now entirely safe in affirming my previous supposition, in bulletin 50, that the Fusarium wilt disease is cosmopolitan in distribution with the culture of flax.

Much can be done in working with our own types of flax seed, but in this case time of accomplishment means much money. The place to find an immune plant is the place where there has been much chance of exposure to disease. The oldest flax growing areas of the intensive flax regions would thus, logically, be the place to go for seed. It is also self evident that the person who is sent should make the selection of seed from the field and not from the seed houses. The selections should be made intensively for resistent types. There are, however, some very sound reasons for believing that one, conversant with the nature of the flax plant and with its parasite diseases, might be able to find strains of flax seed in bulk in some of the older flax raising communities which would be in part or wholly resistent to these general troubles. This is to be expected in localities where intensive methods of hand culture and close selection of seed has been followed for years. Of course, in breeding individual strains of any crop for the purposes just indicated, it is also possible to see to it that a productive variety is obtained. My correspondence and studies have made it clear to me that there are very many different varieties and strains of flax which should be given a trial in such tests. In such work of plant breeding it is the aim of this department to keep well within the study for the purpose of developing the botanical principles which should be followed in the work. The field of work with the cereals, native grasses and forage plants is unlimited but, at present, no work is under way except with flax. Aside from the attempt to obtain a disease resistent flax we have thought that it might be possible to procure a strain more resistent to late spring frosts than the common types of the grain. Some apparently good results have been observed. During the next season we expect to make some extended experiments along that line of thought. A single variety of flax which would be resistent either to the wilt disease or to the light late spring frosts would mean more cash to this state in the results of one harvest than the Experiment Station could possibly cost in ten years.

4. Weed Studies: In previous years considerable experimental work has been expended upon various studies upon weeds. Those studies have some very useful results. This is particularly true of those establishing the depth at which various common weed seeds no longer germinate. The weed problem in this state has several quite

unique features and there are numerous points at which properly aimed experiments could produce desirable information. It is especially desirable to carry out on a more comprehensive plan the experiments of spraying with chemicals to kill weeds in growing grain. These experiments were first inaugurated at this station. The results obtained gave much promise but not sufficient effort was made to bring the matter before the farmers of the state. This nicely illustrates a principle of experiment station work, namely, that an experiment is of slight worth unless it is brought to the notice of the public by a complete demonstration. Our experimental work with copper sulphate as a spray to kill weeds in growing grain was as definite in results as any work which this station has ever done, but for lack of time and means we did not at once carry those results before the interested farmers of the state in the form of conclusive field tests. The result is that, though we have published considerable amount concerning the work in previous reports and in the daily papers not a single farmer in this state is known to have made an effort to profit by the experiment. Since the time of the first experiments in this station, this process of killing weeds has been carried on with marked success by the farmers of Ontario and of England. Such methods cannot fail to be of the greatest economic value in this region; for many have their lands thoroughly filled with such weed pests as king-head and mustard. The first opportunity at which funds are available an extensive demonstration experiment should be undertaken.

5. *Forage and Grass Studies:* During the early days of farming and cattle raising in the state, the number of head of cattle in proportion to the vast areas of native grass lands was comparatively low. The prairies adjacent to the farms and ranches not only easily provided pasture but furnished an abundance of native hay. The time when such native and wild unoccupied lands may be depended upon has already passed, in the more arable portions of the eastern parts of the state, and is rapidly approaching the drier semi-arid grazing regions of the west. In the cultivated areas of the state, the native sod lands have been very generally broken up for the purpose of growing wheat and other cereals. Wherever the rainfall is sufficiently abundant, and the soil is of reasonably heavy quality, but slight difficulty is experienced in resodding the land with the grasses common to cultivation, or in producing heavy crops of the ordinary plants for hay purposes. This, however, is not the case in the lighter drier soils of the western portion of the state. When the native sod is once broken, or destroyed by overpasturing, it is slowly replaced by natural processes, and it is found to be very difficult to get any of the tame grasses or common cultivated forage plants to withstand the summer season of drouth. Such soils, in most cases, wash easily and dry out quickly. It is thus almost impossible, with our present known types of tame grasses, to resod such areas.

In past years, all that country west of the James river and especially west of the Missouri river, has been a great range or grazing area. Lately, because of the introduction of the small farm and cultivation methods, very much of the native sod and grass lands has been destroyed and difficulty is naturally found in procuring growths of tame grasses to take the place of the native ones. On the larger western ranges, as the herds have increased in numbers and the grazing areas have diminished, the effects of overpasturing become more and more apparent. Thus we have received many requests from cattle men for advice as to how they shall proceed in order to keep up the normal forage supply. With the managers of the larger ranges, the question of procuring enough hay or cured forage to tide their herd over the hard winter conditions is an especially difficult one.

Originally the prairie sod was made up of many species of nutritious grasses and legumes, much relished by cattle, the different species growing in tufts, bunches or mats, according to natural differences of life habits. As the herds have increased, the species most relished have gradually disappeared until only the smaller, most hardy, matted forms remain. As the larger bunched sorts have been eaten out, the soil has either remained bare, unsodded or is becoming overrun by wild barley and other types of worthless grasses or weeds. Thus it is, that to learn how to rejuvenate the partly worn out native pasture lands, and how best to produce forage plants for hay purposes becomes one of the most important problems for careful experimental work.

In nature, plants have learned to thrive under almost desert conditions and gradually agriculturists are learning that many of these hardy types may be developed into very valuable domesticated sorts. There are numerous wild plants which are relished by stock that, because of their native growth conditions, we feel sure would be able to withstand the soil and climatic conditions peculiar to those to which they would be subject in the cattle counties of this state. Indeed, there are numerous species of our native grasses and legumes (wild vetches, etc.) which should be given a trial under regular conditions and methods such as we apply to our tame varieties of forage plants and grasses. In order to do this in a proper manner, substations for grass gardens and field experiments upon the native pasture lands should be established in those parts of the state where the climatic and soil conditions are such as we are trying to overcome. I therefore strongly recommend that, as soon as it is possible, funds should be set aside to be used in work upon at least one such grass and forage experimental garden. This garden should be located in the cattle country west of the Missouri river, or if northward, at some point in the vicinity of Minot or westward. Dickinson would be an especially valuable point because of its accessible location and specially characteristic climatic and soil conditions.

To make more clear the possibilities of such an experimental substation or garden, I here indicate four of the points of experimentation which it would be valuable to undertake: (1) Testing of native wild forage and grass plants. (2) The testing of foreign or introduced varieties. (3) Attempts to learn cultivation methods for the cultivation of forage plants in such drier regions, and (4) Special experiments looking towards methods of rejuvenating the native pasture and hay lands in those regions where the growth of cultivated forage plants is impossible.

The work of selecting and testing our native grasses and leguminous plants gives promise of affording the best, or most certain economic results. To give this a fair trial, every effort ought to be made to get together and grow under trial conditions, similar to those which we use for the growth of our common tame kinds, every species of apparently valuable forage or pasture plant, which is native to our sod lands. For this purpose, the establishment of the proposed experimental garden, so that the work of testing may be carried out under the soil and weather conditions characteristic of the areas which we wish to improve, becomes a direct necessity. That there is much hope that we shall succeed in finding some valuable plants among our own native, wild growths is well indicated by the fact that there are numerous species of both grasses and legumes in the virgin prairies which are greedily eaten by stock and rapidly disappear upon overpasturing. We believe, through observation, that this disappearance, in the case of most species, is due to the fact that such plants are most sought after by the cattle. Furthermore, when not overpastured, many of these plants are known to grow in bunches to very considerable proportions. These should be collected either by means of seed collections or sod transplanting, in such manner as to get them growing upon a pure culture basis. We can then readily ascertain their value as producers both of quality and quantity and these trial beds will afford a source for the direct application of the regular principles of selection and breeding to these native plants. The fact that the valuable *Bromus inermis* was obtained for the farming world in essentially this direct way, ought to be a good argument, and sufficiently conclusive to substantiate the desirability of such a garden. The garden already started at the home station should be developed to such an extent as to become useful in the experimental purposes of developing forage plants suitable for the heavier land regions of the state, and to furnish preliminary trials or tests of plants to be tried under other conditions. The head of the division of agrostology of the United States department of agriculture has considered this work to be not only of much importance to the state, but to other regions of the great plains, and offers to furnish some aid, advice and co-operation in the experiments, if such a definite experimental plan is really undertaken by our station. Indeed a small sum has already

been appropriated by the department of agriculture as an aid to a preliminary survey of the matter. The department of agriculture, because of its extensive resources for seed study and exchange, would be able to aid us very materially, especially with regard to the testing of introduced varieties of foreign plants. If possible, therefore, this co-operative work should be continued on the part of this station.

6. The Economic Plant Survey: In direct relationship to the foregoing outline for special work with grasses and forage plants, I wish to call attention to the work of an economic plant survey of the state. Since the station started, some considerable attention has been given to collecting specimens of all of the native and introduced plants of the state, together with all available data and observations concerning the life habits and characters of such plants. The value of the work is well illustrated by the citation of the fact, that from the nature of our work, the botanical department of the Experiment Station of the state ought to be the source of knowledge upon all such matters. For example, the department ought to be able to answer questions concerning any particular native plant as to its value or general nature, whether suitable for forage or possessed of poisonous qualities, whether capable of producing diseases in other plants or animals, etc. To do this, we should have well prepared specimens and should make note by direct observation upon such characters as distribution, soil habits, and any peculiar properties of the plant or features of its life activities. These specimens and notes are filed in permanent form and are thus becoming a valuable source of reference. It was because of such studies that the department was first able to call attention to the occurrence within the state of the poisonous water-hemlock, which every year destroys many head of valuable animals. From its observed habits of growth, and its known poisonous characteristics, it is easy to account for many of the peculiar, apparently special, cases of stock poisoning; and also to give effective directions for the destruction of the weed.

In the pursuit of this survey work, a large accumulation of facts and data are annually obtained which would be of much value to the people of the state, but the funds for publication are so limited that the station is not able to send out the information in a form to warrant the amount of work necessary in the preparation. It is also reasonably to be doubted whether the publication of such reports could be legitimately made from regular government experiment station funds. This illustrates the point that our state should furnish a fund for the Experiment Station which can be used for the more general types of experimentation and publication; for while, perhaps, less interesting than some of the more special types of experiment station work, such facts and observations are often even more valuable because of the direct needs of the people for education upon some of the more common matters of plant life directly

associated with their farm work. When available, an annual fund should be set aside to facilitate a comprehensive, economic, biological survey of the resources of the state, to be associated with and run parallel to the Agricultural college economic geological survey. The fund should not only be sufficiently extensive to cover the cost of travel and collection of specimens and data, but sufficient to allow of the complete publication of results in such form that they may come into the hands of the general reading public of the state.

7. *Physiological Experiments with Trees:* This state needs to grow many more trees of many more kinds than it is at present attempting to do. But, there are many drawbacks, not the least of which are certain well defined pathological and physiological troubles. The trees are attacked by many pests, seem unduly short-lived and, in places, appear to die with provoking ease. During the past year a number of purely physiological experiments have been undertaken upon some problems affecting the nutrition of trees, the use of water by trees, etc. The fellowship assistant, Mr. Thomas Manns, gave one-half of his time during the summer months to some special studies outlined upon the relationship of the water supply to certain of the more destructive blights and rusts upon local trees. Some very interesting facts and observations were recorded. It is hoped to continue these experiments, that we may, in the near future, be able to give more satisfactory explanations regarding certain difficulties in the cultivation of forest and fruit trees. We believe, for example, that there is no legitimate reason that the life of the ordinary tree claim should be limited in its productivity to so short a period as twenty to thirty years, because of the premature death of great numbers of the trees. It is also thought that the blight so characteristically destructive to apple trees in this and other states may yet be successfully controlled or combatted when some happily planned physiological experiment has finally pointed out the way. I therefore call attention to the thought that the legitimate functions of this department must always center around many theoretically planned experiments, which, as in this case, but serve as feelers for new grounds for experimental work. Such experiments, of course, sometimes demand expenditures for which, at the time, there seems to be slight hope of immediate economic returns.

8. *Seed Control Studies:* The cereal crops of this state are grown upon such an extensive plan, and are limited to such a comparatively small number of kinds that the question as to the quality of seed which the farmers generally use for cropping purposes becomes a most important one. Our studies during the past nine years, upon seed germination and seed testing in the laboratories, and upon the trial of injured and diseased seeds in the field, have abundantly testified that upon each of the important cereal crops the farmers of this state lose annually very large sums of money in the harvested returns, because of the inferior quality of seed which is

used. In some communities in the state it seems to be almost an axiom, at least, among the more uneducated classes, that any sort of grain which is injured too badly for market purposes, either because of the presence of such diseased conditions as smut, or because of injuries due to improper methods of harvesting, etc., may properly be used for seed purposes. This is an error which is costing the state many thousands of dollars each year. In the case of the grain simply being imperfect or immature, or injured by weather conditions, the loss to the individual farmers and to the state is only that which is occasioned by the direct loss in yield per acre. In the case, however, where the farmers carelessly use seeds that are thoroughly infected with all types of injurious weed seeds, and with diseases such as the loose smut of oats and the wilt disease of flax, great harm is done, not only to the individual farmer, but to the farmers whose lands are immediately adjacent, and finally to the state at large, because such diseases are infectious and the spores of the fungi which produce them are readily distributed from field to field, and from one part of the state to another, in a great number of ways, as for example, through elevators, common carriers, threshing outfits, and even by the agency of the wind, water, etc.

In order to help those farmers who have desired to know the quality of seed which they are putting into the ground, we have each year examined, and in many cases tested the samples which are sent in for that purpose. The work accomplished has been deemed so desirable by those who have taken advantage of it, that at times the department has been completely unable to examine and test the number of samples which have been sent to the station for that purpose. Much of the work of seed testing can hardly be said to fall within the scope of the regular duties of the station. The work, in large measure, is not experimental at all. It is rather to be looked upon as a type of work to be done as an accommodation to the farmers of the state. Much of it really ought to be done by the farmers themselves, consisting as it does of simple operations, such, for example, as carrying out simple germination tests. However, a very large number of our farmers seem to trust very little to their own judgment upon such matters, and when they do, often induce themselves to believe that very inferior grain may be used for seed, without loss. There are besides some very satisfactory reasons why we ought to continue this process of seed examination, testing and advising. It places the department in direct communication with many farmers and allows us to arrive at an understanding of their needs, in the matters affecting methods of work with seeds. It also gives us a chance to keep a check upon the character of the seeds that are being sold by seedsmen and gives us an opportunity to learn of the weeds and parasitic pests that are being introduced into the state. The study of these seed samples has also been the means of suggesting some of the most important lines of our experimental work.

This work of seed testing and advising as to the use of seeds should be continued, but in order to do so, it should be put upon a broader basis so that the work may be accomplished expeditiously. There are several types of apparatus which should be provided, so that our work may be placed on a uniform basis with the seed testing processes of other seed control stations. At present the processes followed are devised to admit of the greatest speed, because of the lack of time to carry out the more extended, regulation methods generally recommended by the chief seed control stations. Sufficient funds should be set aside to allow the hire of one or more student assistants to carry out the detail of the germination and testing processes. Such extra help would be needed only during the winter and spring months.

A very important feature of this work has been the development of a method of detecting the spores of the various types of parasitic fungi which produce disease in the cultivated crops. We are thus able to give advice as to whether is would be desirable to treat such examined seeds for prevention of disease. The spores of such fungus diseases as flax wilt, stinking smut of wheat, indeed any type of fungus infection of seed grain may quite easily be detected.

9. *Bacteriological Analyses:* There is considerable demand for bacteriological analysis of water, milk, etc. In regard to the water analysis, it is, I believe, important that a regular survey of the waters of the state should be made to ascertain the regular characters of the bacterial flora, thus locating the conditions most favorable to the production of diseases of man and domestic animals. Typhoid fever is very common in the farming districts of the state and is worthy of our attention because of the great loss of life and expense which it causes each year. At first thought, this may not seem to be a question open to the legitimate work of the station, but what is more important to the well being of a farming community than to be able to avoid sickness in the homes and amongst the farm help. I believe that a study of the water supply, such as that indicated, would allow us to give very efficient instructions looking toward helping the people to escape the troubles arising from this disease, and also many other troubles, especially those which affect farm animals because of improper water supplies. Bacteriological culture methods, however, all contemplate the growth of the organisms in many different ways and demand much time and skill upon the part of the investigators. It is thus not desirable to undertake general bacteriological analyses until the laboratory may have sufficient help to allow continuous work upon such experiments, or studies.

10. *Greenhouse and Experimental Culture Rooms:* In making physiological studies upon plants or in attempting to make control experiments upon almost any type of plant disease it is practically impossible to do without properly constructed culture houses in which all conditions of plant growth can be under control. A green-

house for this purpose has been much needed every month since the department has been in existence. It has been impossible to do much experimental work in the line of trial infections with fungi which are suspected of causing plant troubles during the winter and, as we have many months of cold weather each year, it is easy to understand what a handicap the lack of culture rooms is to the different plant studies. I therefore hope that it will not be necessary to enter another winter without such houses for experimental work. Plans will be furnished from the department when desired by you for consideration.

11. The Library of the Department: The first or most important aim of this department of the station work should be to keep the farmers informed concerning the latest and most improved methods of dealing with the principles of plant life and the best information concerning the subject of plant diseases. To do this properly one must be informed upon the work as done throughout the botanical world. Expensive works of research and many magazines or journals for reference are thus a direct necessity of every well equipped department of botany. Our department is most in need of back files of certain quite expensive journals and standard works of reference concerning plant classification, plant physiology and plant diseases. The proper works of reference very largely determine the usefulness of an investigator and make it possible for him to furnish advice upon many questions which otherwise must remain unanswered, or be inefficiently handled. The correspondence of this department continually reminds us that our library is very inadequate.

Summary of Needs with Rough Estimates: The demand of the work of instruction and the details of college work are increasing rapidly. The time of Assistant Professor L. R. Waldron is chiefly devoted to teaching or in preparing the materials and apparatus for instruction purposes and at least one-half of the time of the head of the department is taken by similar types of work. To arrange matters so that experimental processes shall run without interruption, it is important that there should be one person who may work without interference of other duties. I would therefore respectfully request that an expert assistant be assigned to the department of botanical work in the Experiment Station, and that if possible to do so, that Mr. Thomas Manns be retained in that capacity when he has finished his present student work as fellow. There should also be appropriated \$300 for student and common labor, during the coming year.

Aside from the general expenses of salaries and labor, there is direct need as follows:

For greenhouse and experimental culture rooms or cages connected therewith, \$2,000.

For hoods, cases and other additions to the general working equipment of the station laboratory, \$200.

For new apparatus, seed testing, bacteriological and physiological in character, $250.

For traveling expenses, in connection with the grass garden investigations, biological survey and special investigation upon plant diseases, $250.

For current books upon botanical investigation, $100.

For purchase of standard works of reference upon plant diseases, mycology and vegetable physiology, $250, and for the regular files of journals and periodicals, $100.

Thus aside from salaries, labor and the estimate for the greenhouse, the needs of the department approximate $1,150.

Respectfully submitted,

HENRY L. BOLLEY,

Botanist.

AGRICULTURAL DEPARTMENT.

To Director J. H. Worst:

SIR: In submitting the thirteenth annual report of this dapartment I desire to call your attention to the fact that the work of the department has been hindered during the nine years of my incumbancy by frequent changes of assistants, no less than four different persons having held the position of assistant agriculturist during that time while that place is left vacant at the present time by the recent resignation of A. M. Ten Eyck to accept a more lucrative position in the Kansas station. The North Dakota station probably deserves some credit for training these men all of whom are now holding positions in the lines assigned to them for their major work in this department—and with one exception their rank is equal to that of their former chief—but the honor scarcely compensates the station for the service.

The changes which have occurred are the result of the young men seeing an opportunity to earn larger salaries and most, if not all of them, would have been willing to remain with this station for compensation equal to that which was tendered them by the other institutions. I am cognizant of the fact that the state has never appropriated a dollar for the support of the Experiment Station and that the station is limited to the Hatch fund appropriated by the federal government for support and that in consequence the station is forced to adopt a stringent financial policy, but I believe that such frequent changes and the restiveness which results from a feeling that the position is not a permanent one—for an active successful experimenter—reduces the efficiency of the worker in securing results, at least one-third and that it should be remedied if it is possible to do so. Young men who have just emerged from the college doors of some other state—as the men who have assisted me have done—must learn the methods and details of conducting lines of experiment, new climatic and soil conditions, new types of farm machinery and implements, and new methods of conducting farming operations. The writer has found that his time has been sadly decimated by aiding and training these young men and from having been forced to spend much time in looking after the details of experiment work which could have been delegated to more experienced assistants. I believe that additional money used to increase the salaries to an extent which will permit the institution to retain the services of successful young men engaged in experiment work will buy more returns in the results from the trials conducted than does any similar sum now expended.

This department needs a building for the proper storage and curing of seeds. A single berry of wheat planted by this station ten years ago represented vast value and its progeny are now numerous enough to nearly supply the seed wheat of the state. Many of the strains of wheat, corn and other seeds have been subjected to chemical analysis in addition to having had a vast amount of time spent upon them by expert plant breeders and an ounce of seed often represents a large investment in time and expense put into it by the station and a greater value to the state. It often happens that a quart of grain or even a single head has great procreative or hereditary value locked in its seed, which it is certainly short sighted policy to risk losing by fire, frost, mice, birds or other easily prevented perils. The catastrophe of the winter of 1900 when the college barn containing most of the station seed burned, is an example of the damage which may result. There was more value in pedigreed seeds lost in that fire than can be easily estimated. There is a strong demand for a good variety of oats which will be reasonably free from rust, stiff enough in the straw to prevent heavy loss from lodging and a good yielder of plump berried seed and the station would have had such a strain ready in large enough quantity to distribute in 1901 had the loss from fire been averted. The station is badly in need of a suitable storage place for potatoes and root crops. At the present time strains of potatoes representing the best hereditary traits which the station has been able to implant in potato tubers are taking the chance of getting through a northern winter in the primitive and dangerous earthen pit, as that represents less of hazard than any other storage place at my command. With the United States department of agriculture interested and co-operating with this station through direct financial aid to the extent of practically one thousand dollars during the past season it would seem short sighted policy for the station to fail to put five thousand dollars or even a greater sum of money into the construction of a suitable storage place for grains and seeds especially as North Dakota is the sole beneficiary. It seems probable that the good faith in the co-operative seed breeding work which this station will show the United States department of agriculture by the construction of such a building together with the continuation of a good record for producing high grade strains of seed and for successfully distributing improved seeds to the grower will result in continued co-operative aid that will equal the cost of the building in the course of five or six years.

Had this station failed to win the gold medal upon its grain breeding exhibit at the Paris exposition in 1900, and if the breeding and distribution work of the station had failed to show good results and prompt co-operation on the part of our grain growers, I have positive information that the government aid secured during the past season would not have been forthcoming.

PLANT BREEDING AND SEED DISTRIBUTION.

The value of seed breeding and distribution must appeal to every thoughtful citizen. If an improved strain of wheat can increase the yield of that grain one peck per acre in this state it will add to the value of the annual product of the cultivated area of the state at least five hundred thousand dollars per year. The strains of wheat known as North Dakota No. 66 and Minnesota No. 163, which were originated by the breeding work done at this station, will each produce at least two pecks more wheat per acre than will the seed wheat which was previously sown in North Dakota, besides producing a higher grading crop. Those strains of seed alone are worth a million dollars a year to the state of North Dakota and if the station cannot put out more than one improved strain of their capacity in ten years it will still prove one of the best investments the state in co-operation with the general government has ever made. The readiness with which the grain growers of the state have taken the improved strains of grain and the better kinds of introduced plants has been a source of great satisfaction to the station. The general progressiveness and desire for improvement on the part of the producers of the state has enabled the station to accomplish vastly more than it would have been possible to do if our people had co-operated less cordially with the station.

Austrian brome grass, dwarf essex rape, North Dakota No. 66 wheat, North Dakota No. 100 corn, macaroni wheat and the improved strains of potatoes which the station has distributed and recommended for trial have all been promptly taken up, tried and reported upon by the people of the various parts of the state and they have greatly accelerated the selection and distribution of the better strains and varieties of field crops grown in the state.

The United States department of agriculture has aided materially in the work of developing improved strains of argicultural seed grains by supplying the station free of charge seeds from remote districts of country with similarly rigorous climates, and by supplying the station with expensive special implements and other needed appliances and by supplying a man to aid in the seed breeding work under the direction of the officers of this station.

The work in plant breeding and seed distribution has been enlarged and extended. During the past season the station grew individual plants in the breeding nursery as follows:

Fife wheat	4,800 plants
Blue stem wheat	3,500 plants
Macaroni wheat	300 plants
Cross bred wheat	2,200 plants
Total number of wheat plants	10,800

The above wheat came from 21 stocks of fixed type and 30 stocks of unfixed or variable types.

Side oats	700	plants
Whorled or branching oats	2,900	plants
Total number of oat plants	3,600	

The oat plants have sprung from four different stocks.

Barley—Bearded, six rowed	2,400	plants
Barley—Hulless	800	plants
Total number of barley plants	3,200	

The barleys in the plant nursery have sprung from four different stocks.

Buckwheat—light colored seeds	500	plants.
Buckwheat—dark colored seeds	900	plants.
Buckwheat—four cornered seeds	25	plants.
Buckwheat—rye type of seeds	100	plants.
Total number of buckwheat plants	1,525	
Flax bred for fibre	1,400	plants.
Flax bred for seed	2,900	plants.
Total number of flax plants	4,300	

The flax plants in the nursery are descended from eleven stocks.

Millet bred for fodder	400	plants
Millet bred for seed	1,700	plants.
Millet bred for seed and fodder	200	plants.
Total number of millet plants	2,300	

The millet plants in the station nursery are descended from five stocks of seed.

Slender wheat grass	518	plants.
Austrian brome grass	518	plants.
Grimm alfalfa	945	plants.
Turkestan alfalfa	21	plants.
Total number of grass and alfalfa plants	2,002	

BREEDING FOR HIGH PROTEIN CONTENT IN CORN.

The work in corn as well as much of the work in improving the quality of wheat is carried on in co-operation with Professor E. F. Ladd, of the chemical department of the station, who does the analytical work in the trials and counsels with the writer in planning them. Sixteen ears of North Dakota No. 100 corn with percentages of protein ranging from 13.13 per cent to 15.44 per cent have been grown separately and the seed from the best individual ears from them are now in the hands of the chemist so that the analyses will be completed before time for planting the grain next spring. Five ears of golden dent corn with protein ranging from 11.56 per cent to 14

per cent were planted last spring and the resulting plants have been harvested for analysis. Five ears of North Dakota No. 100 corn selected for low protein content with the protein percentage ranging from 9.50 per cent to 12.56 per cent are in the trial and produced a number of plants during the past season which will be analyzed as a part of the breeding trial.

During the past season 226½ bushels of macaroni wheat was distributed by sale to North Dakota wheat growers. One hundred eighty-four bushels of Minnesota 163 fife wheat was also sent out to the grain growers of North Dakota. Twenty bushels of a highly bred seed corn known as North Dakota No. 100, which represents nine years of breeding by this station, was sent out in lots of one-half bushel or less per man. Twenty-four bushels of seed potatoes were also distributed by sale during the past spring. Seeds of the above improved grains and potatoes were sent to 119 grain and potato growers in the state during the past year.

RED CLOVER FROM VARIOUS STATES AND COUNTRIES.

In a co-operative trial with the bureau of seed and plant introduction of the United States department of agriculture this station planted clover seed from sixteen different states and countries. The object of the trial is to learn whether the seed produced from plants acclimated to any particular district will prove more hardy in this section of country than the ordinary seed which is sold upon the market. The seed was sown in the spring of 1901 in plats containing eight square rods each. Almost all of the sorts made a reasonably good showing during the first season. The plats were sown without a nurse crop and the weeds were cut off with a mower to prevent their ripening seed and to keep them from shading the clover too much. The clover plats were injured in the spring of 1902 by heavy rains causing water to stand upon the ground for several days and upon a portion of it long enough to destroy the clover plants. The water did not stand over the entire plat seeded to any one kind of clover long enough to seriously injure it so that the trial was not as seriously interfered with as it would have been if the flooding had been more general.

The clover seed was furnished by A. J. Pieters of the division of seed and plant introduction, bureau of plant industry, United States department of agriculture, Washington, D. C., and includes clover seed from the following districts, states and countries: Tennessee, Michigan, Minnesota, Oregon, Missouri, Ohio, Kentucky, Indiana, Pennsylvania, Russia, Hungary, Italy, Silesia, England, Canada, Stiermarck.

The chief object of the trial is to determine whether there is a race of red clover acclimated to any of the districts of country selected which will prove hardy in North Dakota or if any of them will form good foundation stock to breed a hardy strain from.

The plats were injured too seriously by flooding for the comparative yields to be considered thoroughly reliable as the irregular shape of the remaining portion of the trial plat made it impossible to do more than estimate closely the size of the plat in some instances. It was a matter of judgment also where the limit of the injury by flooding reached while the irregular sizes of the remaining portions of the different plats of the series makes such a comparison lack some of the features which are conducive to accuracy.

The writer's experience on the station grounds in earlier trials with red clover resulted in the plan of cutting a single crop from the plats and of allowing the second growth to hold the snow during the winter and thus form a protection to the crop and supply the land with additional seed each season.

The English clover did not survive the rigors of the first winter and was thus an unqualified failure. Clover from the seed obtained from Minnesota, Canada and Tennessee are the only strains which produced much seed. The seed of most of the varieties was green and badly shriveled at the close of the season, but the seed from the Minnesota and Canada strains matured and was reasonably plump. Clover from seed which had been grown in North Dakota for seven years, which grew upon an adjoining plat, made a heavy yield of ripe, plump seed. A number of heads from the North Dakota seed were shelled and the contents counted, the range was from 34 to 107 seeds per head, while the average number was 62 seeds per head. The clover upon several of the plats lodged badly and does not constitute promising stock on that account. According to the record of yields which was secured, the Missouri, Minnesota, Silesian, Ohio and Tennessee strains ranked highest and in the order named.

The trial must run for several seasons for sufficient evidence to accumulate in favor of any one of the various sorts to warrant the recommendation of it for general field sowing in the state. It is much more probable, however, that some of the strains of seed in the trial may furnish a foundation stock which can be bred up and acclimated to North Dakota conditions than that any one of them will prove hardy and ready for introduction without any modification.

Of the entire list of seeds in the trial none seem as promising as the strain which the North Dakota station and seasons have exerted their acclimatizing and selecting influence upon for seven years. The original seed of the strain thus bred up was purchased upon the market as common seed but it probably grew in Minnesota.

ALFALFA TRIALS.

Turkestan Alfalfa—The two and one-third acre plat of land—reported upon in the twelfth annual report of the station, page 47—made a good growth in 1902, and showed no signs of winter killing. The leaves of the plants were severely attacked by a rust which

caused them to drop off badly. The crop was cut for hay during the first week of July and made a yield of 2,729 pounds per acre. Heavy rains fell during the time the hay was in the swath, which resulted in a heavy loss in weight by causing the leaves to fall off badly, in addition to the material leached out by the water. The second growth came on vigorously and was allowed to stand until the plants were killed by frost to determine whether the seed which had formed would ripen. The seed failed to ripen and the frost caused a heavy loss of the leaves and the finer portions of the stems in the second crop, which made a yield of only 1,189 pounds of hay. The total yield of the plot per acre is 3,918 pounds, or practically two tons. Had the cuttings of hay received ordinary treatment the total yield would, in my judgment, have exceeded two tons per acre.

An adjoining piece of land was seeded to Turkestan alfalfa in the spring of 1902 on summer fallowed land and without a nurse crop. It made a reasonably good stand and a strong growth of plants. The stand and condition of the plat was similar to that recorded for the one sown in 1901 except that very few yellowish colored areas of plants appeared in the plat.

Grimm Alfalfa—Seed of a Minnesota strain of alfalfa named Grimm by the Minnesota Experiment station was seeded upon a plat of land adjoining the Turkestan alfalfa last spring. The growth of plants came on more quickly and they seemed somewhat more sturdy than those from the Turkestan seed. As the winter season seems to be the trying time for alfalfa in this district there will be little basis for a report—which will have value until a year hence.

VARIETIES OF WHEAT.

Forty-eight varieties of wheat were grown in the regular field trial made by the station in 1902. These varieties included the ones grown in 1901—the results for which were published in the twelfth annual report, page 49—two or three older ones and a number of cross bred and selected sorts which originated at this station.

The land used for the trial in 1902 was planted with corn and potatoes in 1901 and was not plowed for the wheat trial. The land was disc-pulverized on April 29th and 30th in preparation for sowing. Rain fell on May 1st, 3d, 5th and 6th and all farming operations were suspended until May 9th. Wheat sowing was begun May 9th.The ground was very wet, too wet for the drills to do good work. The following varieties were sown May 9th: Nos. 197, 247, 249, 250 and 251. See table 1. The Dowagiac shoe drill was used in this trial. Rain fell again on the afternoon of May 9th and seeding was not resumed until May 12th, and at that date the land was very sticky and soft. The ground was so soft that little effort was made to cover the grain. The chains were taken off and the seed was sown very shallow and covered by harrowing two or three days after the grain was sown. The remaining

varieties were sown on May 12th, 13th and 14th. The seed wheat was all treated with formaldehyde for smut and was seeded at the rate of seven pecks of treated seed to 5½ pecks of dry seed per acre. The macaroni varieties were seeded at the rate of eight pecks of treated seed to six pecks of dry seed per acre.

Rain fell each day from May 16th to 19th inclusive. Nearly two inches of water fell in four days and as a result the ground was fully saturated and in places flooded. On account of the wet, cold condition of the soil, the wheat germinated slowly and very poorly. On May 23d it was observed that the grain was up quite well on the first plots sown, but it was coming up only on the highest spots of the later plots. The ground was very hard and the surface had baked. All of the plots were harrowed May 23d with a slanting tooth, iron harrow, which broke the hard crust and did little or no damage to the grain.

On June 25th the wheat stood from ten to fourteen inches high on several of the plots and was a fair stand except in a few spots but it was rather wavy in appearance and irregular in growth. The macaroni varieties appeared to be the most thrifty. All of the varieties had been injured by the wet weather, and the ground was very hard and badly baked in places. The grain sown first when the soil was the muddiest made the best and most even stand, probably on account of the soil failing to bake over it by reason of the rain which followed. That sown just before the excessive rains was so poor in spots that they had to be cut out and the area deducted from total area of the plots before the yields were calculated.

The wheat stooled well and made a rapid growth. On July 12th it was observed that No. 276, Medah macaroni wheat, was heading. The other varieties began heading a few days later. The latter part of the season was favorable to all grain crops. Wheat filled well and ripened slowly. The macaroni varieties lodged badly which reduced their yield. The blue stem varieties also lodged badly and gave a comparatively poor yield. Fife wheat stood up well and made a good crop. The straw of all of the varieties was generally bright with very little rust. Harvest began August 13th and was completed August 23d, except in the case of No. 284, Polish wheat, which was not ready to cut until August 29th.

The Champion Harvester company presented the Agricultural college with one of their new binders to be used in the experiment work. This binder was used to cut the 1902 crop and met with all kinds and conditions of grain. It did good work even where the grain was badly lodged. The grain was threshed from the shock September 7th and 8th, and was in good condition.

Table 1 gives the data recorded for the 1902 crop and includes the average yield for 1901 and 1902, of the varieties which have been in the trial during both seasons.

TABLE I.—VARIETIES OF WHEAT—CROP OF 1902.

Bulletin No.	Variety	Class	Where From	Days maturing	Length of stem—in.	Bearded, Smooth or Velvety Chaff	Length of heads—in.	Grade	Grade: Weight per bu.—pounds	Grade: Yield per Acre—bushels	Grade: Average Yield of 1901 & 1902—bu.
197	Preston	Cross-bred	Prof. Wm. Saunders, Ottawa, C.	97	43	Bearded	3¼	3N	58	25.0	25.4
247	Advance—Minnesota No. 185	Cross-bred	Minnesota Experiment Station	96	44	Bearded	3¼	2N	59	19.5	19.6
23	Red	Fife	Agr. College, Guelph, Ont.	101	44	Smooth	3	2N	59¾	21.3	
50	Wellmans	Fife	Exper. Farm, Brandon, Man.	101	45	Smooth	3	1N	60¾	21.8	
236	Wellmans	Fife	Exper. Farm, Brandon, Man.	101	45	Smooth	3¼	1N	59¾	22.7	
249	Selected Powers—Minn. No. 149.	Fife	Minnesota Experiment Station	98	45	Smooth	3⅛	1N	60½	23.6	23.2
250	Sel. Glyndon (818)—Minn. No. 155	Fife	Minnesota Experiment Station	98	46	Smooth	3¼	1N	59¾	24.1	24.7
251	Sel. Rystings—Minn. No. 171	Fife	Minnesota Experiment Station	103	48	Smooth	3¾	2N	59	26.8	26.4
252	Sel. McKendrys—Minn. No. 181	Fife	Minnesota Experiment Station	98	48	Smooth	3½	1N	60¼	24.0	25.6
253	Saskatchewan	Fife	Northrup, King & Co.	100	45	Smooth	3	1N	60½	24.1	25.7
254	Pillsbury	Fife	Northrup, King & Co.	100	45	Smooth	3	1N	60½	24.8	25.9
255	White	Fife	Wm. Rennie, Toronto, Canada	100	45	Smooth	3	2N	59¾	21.9	24.1
256	Red Fern	Fife	Wm. Rennie, Toronto, Canada	100	44	Smooth	3½	2N	59	23.4	25.0
257	Selected Minnesota No. 285	Fife	Minnesota Experiment Station	101	47	Smooth	3¾	1N	60½	25.3	27.6
258	Selected Minnesota No. 288	Fife	Minnesota Experiment Station	101	48	Smooth	3⅝	1N	61	25.8	25.4
259	Selected Minnesota No 292	Fife	Minnesota Experiment Station	101	43	Smooth	3¼	1N	60¾	22.7	23.4
260	Selected Minnesota No. 293	Fife	Minnesota Experiment Station	100	44	Smooth	3½	2N	60	25.6	25.6
261	Experiment Station No. 66	Fife	John Davis, Buxton, N. Dak.	100	45	Smooth	3	1N	60½	23.1	23.1
285	Early Wonder	Fife	L. L. May & Co.	100	45	Smooth	3⅝	2N	60	23.4	
286	Wilcox	Fife	W. W. Wilcox, Kempton, N. D.	101	48	Smooth	4	1N	59½	22.8	
288	North Dakota crossed	Fife	North Dakota Exper. Station	101	44	Smooth	3½	1N	60¾	21.6	
289	North Dakota cross-bred	Fife	North Dakota Exper. Station	100	48	Smooth	3¾	1N	60¾	27.8	
290	North Dakota cross-bred	Fife	North Dakota Exper. Station	101	48	Smooth	4	2N	59¼	25.4	
291	North Dakota cross-bred	Fife	North Dakota Exper. Station	101	46	Smooth	3¼	1N	60½	23.0	
262	Haynes' Pedigree	Blue stem	L. H. Haynes, Fargo	102	48	Velvety	3¾	1N	59¾	24.1	26.1
263	Marvel	Blue stem	John A. Salzer Seed Co.	102	50	Velvety	3¾	1N	58½	21.2	24.8
264	Haynes' Minnesota No. 51	Blue stem	Minnesota Experiment Station	104	51	Velvety	3⅞	2N	58½	21.1	25.4
265	Bolton's Minnesota No. 146	Blue stem	Minnesota Experiment Station	103	51	Velvety	3⅞	2N	57¾	17.5	23.6
266	Haynes' selected Minn. No. 169	Blue stem	Minnesota Experiment Station	103	51	Velvety	3⅞	2N	57¾	18.1	24.2
267	American	Blue stem	Wm. Rennie, Toronto, Canada	103	51	Velvety	3⅞	2N	57	19.6	25.1
287	Selected Haynes'	Blue stem	North Dakota Exper. Station	102	50	Velvety	4	2N	59½	23.8	

202	White Russian—Minn. No. 192...	Wh. Russian	Minnesota Experiment Station..	100	45	Smooth......	3½	†2N	59	21.2	
222	Pererodka—U. S. No. 2954........	Macaroni ...	Russia by U. S. Dept. of Agr.....	101	53	Sm., bearded	2¾	No.2	62½	25.7	
268	Aronautka........................	Macaroni ...	I. N. Oium, Lisbon, N. D.........	103	53	Sm., bearded	2⅝	No.2	62	28.7	31.4
269	Wild Goose......................	Macaroni ...	Wm. Rennie, Toronto, Canada ..	103	52	Sm., bearded	2½	No 2	62	26.3	29.7
270	Berdianska—U. S. No. 1586.......	Macaroni ...	Russia by U. S. Dept. of Agr.....	102	53	Sm., bearded	2½	No.2	62½	28.7	29.2
271	Navorossisk—U. S. No. 1567......	Macaroni ...	Russia by U. S. Dept. of Agr.....	102	49	Sm., bearded	2½	No.1	63	20.6	27.0
273	Argentine—U. S. No. 1740........	Macaroni ...	Marseilles, Fr., by U. S. Dep. Ag.	102	51	Sm., bearded	2½	No.2	63¾	29.5	29.0
274	Tagonrog—U. S. No. 1570.........	Macaroni ...	Tagonrog, Rus., by U. S. Dep. Ag.	101	50	Sm., bearded	2½	No.2	63¾	31.7	30.8
276	Medeah—U. S. No. 1381...........	Macaroni ...	Algeria by U. S. Dept. of Agr....	101	53	Sm., bearded	2½	No.2	61½	29.4	27.2
277	Yell'w Gharnovka—U. S. No. 1444	Macaroni ...	Ambiocievka, Rus., U. S. Dp. of A.	101	53	Sm., bearded	2½	No.2	63	33.0	31.9
278	Gharnovka—U. S. No. 1443.......	Macaroni ...	Ambiocievka, Rus., U. S. Dp. of A.	101	50	Sm., bearded	2½	No.2	63½	25.8	28.6
279	Black Don—U. S. No. 1446	Macaroni ...	Ambiocievka, Rus., U. S. Dp. of A.	100	50	Velv., b'rded	2½	**	63	33.3	29.1
280	Gharnovka—U. S. No. 1447.......	Macaroni ...	Tagonrog, Rus., by U. S. Dep. Ag.	101	51	Sm., bearded	2½	No.1	63½	30.3	31.4
281	Beloturka—U. S. No. 1520........	Macaroni ...	Russia by U. S. Dept. of Agr.....	101	53	Sm., bearded	2½	No.1	63	29.9	31.3
282	Kubanka—U. S. No. 1440.........	Macaroni ...	Malsk, Fer., Rus., U. S. Dep. Ag.	101	53	Sm., bearded	2½	No.2	62	28 7	30.6
283	Velvet Don -U. S. No. 1445.......	Macaroni ...	Ambiocievka, Rus., U. S. Dp. Ag.	100	51	Velv., b'rded	2¾	No.2	64½	32.5	31.1
284	Polish—U. S. No. 1565............	Flint	France by U. S. Dept. of Agr....	107	46	Smooth......	4	***	59	14.9	18.0

†Soft. ** No grade, mixed. *** No grade.

TABLE II.—VARIETIES OF WHEAT IN EACH CLASS GIVING LARGEST YIELDS IN 1902.

Bulletin No.	Variety	Class	Grade	Weight per bu.—pounds	Yield per Acre—bushels
277	Yellow Tagonrog	Macaroni	No. 2	63	33.0
283	Velvet Don	Macaroni	No. 2	64½	32.5
279	Black Don	Macaroni	n. g , mx.	63	32.3
274	Tagonrog	Macaroni	No. 2	63¾	31.7
280	Gharnovka	Macaroni	No. 1	63½	30.3
281	Beloturka	Macaroni	No. 1	63	29.9
289	N. Dak. Cross Bred	Fife	No. 1	60¾	27.8
251	Selected Rystings	Fife	No. 2	59	26.8
258	Selected Minnesota No. 288	Fife	No. 1	61	25.8
260	Selected Minnesota No. 293	Fife	No. 2	60	25.6
290	N. Dak. Cross Bred	Fife	No. 2	59¼	25.4
257	Selected Minnesota No. 285	Fife	No. 1	60½	25.3
254	Pillsbury	Fife	No. 1	60½	24.8
262	Haynes' Pedigree	Blue Stem	No. 1	59¾	24.1
287	Selected Haynes'	Blue Stem	No. 2	59½	23.8
263	Marvel	Blue Stem	No. 1	58½	21.2
264	Haynes	Blue Stem	No. 2	58½	21.1
267	American	Blue Stem	No. 2	57	19 6
197	Preston	Bearded	No. 3	58	25.0

In yielding capacity the macaroni varieties stand first. The seed from the United States department of agriculture in 1901, this being the second crop from the original seed which was imported from Russia. All of the macaroni wheats grown at this station are bearded and most of them have smooth chaff. Velvet Don and Black Don are two velvet chaff varieties, both of which yielded well in 1902, but in 1901 they did not produce as well nor appear so hardy as did several of the smooth chaff varieties.

North Dakota No. 289, the best producing fife wheat grown in 1902, is a cross bred wheat which was produced at this station by crossing Power's five upon Hayne's blue stem. The type of this wheat is a rank fife, with long, coarse heads. It is not only a heavy yielder but also grades well.

Selected Rysting's fife, No. 251, is one of the wheats bred up by the Minnesota station and by them as Minnesota 171. That variety of wheat has been grown by this station for five seasons and has proved one of the best producers, standing at the head of the fife varieties which have been tested for that period. It is a rank, long headed fife but it is inclined to be a little starchy and does not grade so well as Experiment Station No. 66 and other standard fife varieties.

It will be observed that the best yielding varieties, both of fife and blue stem sorts, are selected wheats, viz: Varieties which have been carefully bred for improvement at this station, at the Minnesota station or by the late Mr. L. H. Haynes, Fargo, N. D., the originator

of the Haynes blue stem wheat and the pioneer in wheat breeding in the northwest.

The blue stem varieties did not produce as well as the fife varieties last season, which was doubtless due to the fact that the blue stem wheat made too rank a growth and lodged badly, which kept it from filling naturally.

Comparing the average yield of the three best producing varieties in each class for the year 1902 gives the following:

Class	Yield per A.—bu.	Difference—bu.
Macaroni	32.6	
Fife	26.8	5.8
Blue Stem	23.0	9.6
Fife and Blue Stem	24.9	7.7

The macaroni sorts yielded 5.8 bushels per acre more than the fife and 9.6 bushels more than the blue stem, or 7.7 bushels more than the average of the fife and blue stem varieties taken together. The fife yielded 3.8 bushels more on the average than the blue stem. As an average for nine years' trials at this station the yields of fife and blue stem stand as follows:

Blue stem.......................... 24.7 bushels per acre.
Fife .... 24.3 bushels per acre.

The fife has graded a little better on the average than the blue stem. The yield of macaroni wheat as compared with the yield of fife and blue stem for four crops is given below:

Crop	Yield per acre		
	Macaroni—bu.	Blue stem and Fife—bu.	Difference—bu.
1899	34.9	26.6	8.3
1900	20.5	23.6	—3.1
1901	33.1	28.6	4.5
1902	32.6	24.9	7.7
Average	30.3	25.9	4.4

It was noted in the twelfth annual report, page 53, that macaroni wheat required a little thicker seeding than other strains. The macaroni wheat was sown at the rate of six pecks per acre last season, one-half more than was sown of fife or blue stem, and the stand of macaroni wheat was not too thick. The difference in yield in favor of the macaroni varieties was greater this year than it was in 1901, notwithstanding the fact that the macaroni wheat lodged worse than the other sorts.

TABLE III.—FIVE VARIETIES IN EACH CLASS GIVING LARGEST AVERAGE YIELDS FOR TWO SEASONS—1901–1902.

Bulletin No.	Variety	Class	Grade		Weight per bu.—pounds	Yield per Acre—bushels
			1901	1902		
277	Yellow Gharnovka	Macaroni	No. 2	No. 2	62⅜	31.9
268	Aronautka	Macaroni	No. 2	No. 2	62	31.4
280	Gharnovka	Macaroni	No. 2	No. 1	62¼	31.4
281	Beloturka	Macaroni	No. 2	No. 1	62½	31.3
283	Velvet Don	Macaroni	No. 3	No. 2	62¼	31.1
257	Selected Minnesota No. 285	Fife	No. 2 N	No. 1 N	60¼	27.6
251	Selected Rystings	Fife	No. 3 N	No. 2 N	59⅓	26.4
254	Pillsbury	Fife	No. 3 N	No. 1 N	59¼	25.9
253	Saskatchewan	Fife	No. 3 N	No. 1 N	59⅜	25.7
252	Selected McKendrys'	Fife	No. 3 N	No. 1 N	59⅜	25.6
262	Haynes' Pedigree	Blue Stem	No. 2 N	No. 1 N	58⅞	26.1
264	Haynes'	Blue Stem	No. 2 N	No. 2 N	58⅞	25.4
267	American	Blue Stem	No. 2 N	No. 2 N	58	25.1
263	Marvel	Blue Stem	No. 2 N	No. 1 N	58¼	24.8
266	Selected Haynes'	Blue Stem	No. 2 N	No. 2 N	58⅝	24.2

As an average for the two crops Aronautka macaroni wheat, a Dakota bred variety, stands at the head in yielding quality, Minnesota No. 285 has been the best producing fife variety and Haynes' Pedigree blue stem has given a larger average yield than others in its class. The first two varieties named also stood at the head of their respective classes in 1901, and were described in the twelfth annual report, page 52.

DIFFERENT DATES OF SOWING WHEAT.

In 1902, wheat was sown at different dates as stated in Table IV. Most of the ground used for the experiment had been planted with corn or potatoes in 1901 and was not plowed for wheat. The results reported in Table IV. are—in several cases—the averages from two or more plots which were sown on the same date. The ground was cultivated and put into condition to receive the seed at each sowing. The rate of seeding was five pecks per acre of wheat. The following table (IV.) gives the data obtained:

TABLE IV.—DIFFERENT DATES OF SOWING WHEAT, 1902.

Plot No. 5	Date of Sowing	Description of Land Seeded	Condition of Soil at Seeding	Stand of Grain—per ct.	Date Ripe	Days Maturing	Height of Straw—inches	Length of Heads—inches	Yield per Acre—bushels	Weight per bu.—pounds	Grade
1	April 30	Corn in 1901	Wet, but workable	100	Aug. 14	106	48½	3⅜	27.6	59	
2	May 9	Corn in 1901	Very wet and muddy	95	Aug. 15	98	48	3¾	26.8	59	
3	May 15	Corn in 1901	Too wet to work well	98	Aug. 20	97	48	3¾	27.0	61	
4 & 5	May 24	Corn and potatoes in 1901	Fair at surface	95	Aug. 28	96	43½	3¾	20.0	60¼	No. 2 Nor.
7 & 8	May 30	Corn, pota. & sum'r fal'w in 1901	Rather hard and lumpy	89	Sept. 3	96	39	3⅜	18.5	59⅓	No. 1 Nor.
9 & 10	June 9	Potatoes and wheat in 1901	Good	85	*Sep. 11	94	36	3	11.4	55¾	Rejected
11	June 17	Potatoes in 1901	Good	60	Frosted	...	33	3	3.6	44	No grd, scrn'g

*This wheat was ripe enough to cut Sept. 11th, but was not cut until Sept. 13th, and was injured some by frost Sept. 12th.

The yields from the earlier sown plats were the larger. The first three sowings, on April 30th, May 9th and May 15th produced about the same yield. The heaviest and best grading wheat was produced by the May 15th sowing. Good crops of wheat were harvested from the plots sown May 24th and May 30th. Plots sown after the later date gave a small yield and the wheat was injured by frost and rendered unmarketable.

The number of days required for maturing the crop were about the same for each sowing except for the earliest grain seeded, which required eight days longer than the wheat sown May 9th. In other words the earliest sown grain ripened only one day ahead of that sown nine days later. The period from April 30th to May 9th was very wet and cold, and the trial indicates that the wheat lay in the ground practically dormant during that time. The early sown grain stooled most and produced the longest straw and the largest heads. The results of the trial favor early sowing, although for the production of grain of the best quality, the medium sowing has the advantage.

VARIETIES OF OATS.

Forty varieties of oats were grown in the field trial in 1902. The trial included the varieties tested in 1901, a few new varieties secured from the seedmen last spring and several old varieties, the seed of which was saved in small quantities from the fire which burned the college barn in January, 1901, and was increased sufficiently in 1901 to be placed in the regular field trial in 1902.

All of the varieties were sown May 22d and 23d on land which was summer fallowed in 1901. The method of rotation on the trial grounds of this station is to follow wheat with oats and the trial should have been made which on land produced wheat 1901, but as the field of fall plowed wheat stubble became very wet from the excessive rains it was necessary to select other land in order that the seeding might not be too much delayed. The piece of summer fallow selected was a higher, better drained field and the smooth, firm surface prevented the soil from becoming as wet as the rough, mellow fall plowing. The soil, although wet, was worked with the disc and acme harrows ahead of the drill and was in a fair condition of tilth when seeded. The grain was sown shallow and the drill was followed with the harrow to better cover the seed. The seed was not treated for smut and was sown at the rate of nine pecks per acre.

On May 29th the oats were up nicely on the first plots sown. The crop made a rapid growth and on June 25th the grain averaged eleven to thirteen inches in height, was an excellent stand, very clean and was dark green in color on all of the plots. It was noted that No. 84 sixty day oats was heading July 12th. The rich soil and favorable season caused too rank a growth of straw by most of the varieties and the oats lodged and rusted badly. The heads were

large and long but failed to fill properly and the grain proved to be light and shrunken. On account of the rust and lodging, the oats did not ripen naturally, and in some cases the dry plants retained a greenish color. The trial cannot be considered a fair comparison of the varieties, for average conditions, but may be of value in showing what the different varieties can do under adverse conditions.

No. 84, sixty day oats, was ripe and cut August 4th. The general harvest began August 14th and was completed August 25th. The grain was all cut one way and was practically all saved. The oats were threshed September 8th and 9th from the shock and were in good condition.

Table V. gives the data secured in the 1902 trial and includes the average yields for both 1901 and 1902, of those varieties which were grown both seasons.

TABLE V.—VARIETIES OF OATS—CROP OF 1902.

Bulletin No.	Variety	Where From	Days Maturing	Length str'w—in.	Form of Heads	L'n'th of h'd—in.	Lodged—per ct.	Rust—per ct.	Color of Berry	Size of Berry	Shape of Berry	Weight per bu.—pounds	Yield per Acre—bushels	Average for Two Crops—1901-1902
84	Sixty Day—U. S. No. 5938	Russia by U. S. Dept. of Agr.	74	40	Whorled	6	60	*	Yellow	Small	Slender	34	72.2	61.3
113	N. Finland Wht —U. S. No. 5140	Koivikko, Fin , by U. S. D. of A.	81	51	Whorled	9	60	60	White	Large	Long	19½	31.2	....
2	Archangle	College Farm	82	44	Whorled	9	90	40	White	Med. sm.	Short	27¾	34.1	....
51	Sweedish Sel.—U. S. No. 2788	Russia by U. S. Dept. of Agr.	82	40	Whorled	8	70	70	White	Small	Short	25¼	30.8	....
46	Selected Black Beauty	North Dakota Exper. Station	83	42	Whorled	8	75	60	Brown	Small	Med. sln.	27¼	44.3	....
42	U. S. No. 3	Russia by U. S. Dept. of Agr.	84	41	Whorled	9	80	70	White	Medium	Med. l'ng	24	41.8	....
50	Tobolsk—U. S. No. 2800	Russia by U. S. Dept. of Agr.	84	52	Whorled	11	90	70	Lt cr'm	Small	Med. sh't	27¼	36.9	....
111	Czar of Russia	H. Hammond, Fifield, Mich.	84	50	Whorled	9	95	85	White	Large	Sh, plmp	20	34.5	....
48	Zhelarmii—U. S. 2963	Russia by U. S. Dept. of Agr.	85	44	Whorled	8	95	80	White	Med. lrg.	Long	21½	36.2	....
85	Silver Mine	J. A. Salzer Seed Co.	85	46	Whorled	9	95	50	White	Med. lrg.	Med. l'ng	22½	39.2	50.1
86	White Bonanza	J. A. Salzer Seed Co.	85	48	Whorled	10	95	75	White	Large	Medium	24½	37.5	47.3
87	Big Four	J. A. Salzer Seed Co.	85	49	Whorled	10	95	75	White	Medium	Med. l'ng	24¾	41.6	50.2
88	Great Northern	J. A. Salzer Seed Co.	85	47	Whorled	9	90	75	White	Medium	Medium	22½	38.5	47 3
89	Bow of Promise	J. A. Salzer Seed Co.	85	49	Whorled	9	95	75	White	Med. lrg.	Short	23¼	36.6	48.5
96	White Wonder—Minn. No. 32	Minnesota Experiment Station	85	47	Whorled	10	90	85	Lt cr'm	Med. sm.	Med. l'ng	24	25.8	42.6
112	N. Finland Blk.—U. S. No. 5139	Koivikko, Fin., by U. S. D. of A.	85	42	Whorled	7	100	60	Brown	Med. lrg.	Med. l'ng	19½	17.3	....
116	Golden Chester	L. L. May & Co.	85	46	Whorled	8	100	90	Yellow	Large	Med. l'ng	21½	38.8	....
117	White Russian	L. L. May & Co.	85	50	Whorled	9	90	90	White	Med. lrg.	Long	24¼	40.9	....
118	Scottish Chief	L. L. May & Co.	85	48	Whorled	9	99	90	White	Med. lrg.	Sh, p'mp	25	40.9	....
119	20th Century	J. A. Salzer Seed Co.	85	46	Whorled	9	98	90	White	Large	Sh, plmp	25¾	41.8	....
82	American White Banner	**Missouri Experiment Station	86	45	Whorled	10	85	70	White	Large	Med. l'ng	21½	33.5	44.4
93	Lincoln	Oscar H. Will & Co.	86	45	Whorled	9	95	85	White	Large	Long	22	33.9	45.7
94	Early Gothland—Minn. No. 26.	Minnesota Experiment Station	86	46	Whorled	10	80	80	White	Medium	Medium	24	36.4	48.5
95	Improved Ligowa—Minn No. 6	Minnesota Experiment Station	86	44	Whorled	9	95	80	White	Med. lrg.	Med. sh't	25	40.7	47.8
97	Minnesota No. 103	Minnesota Experiment Station	86	42	Whorled	8	50	40	White	Medium	Med. l'ng	23½	25.8	42.6
100	Siberian White	Wm. Rennie, Toronto, Canada	86	42	Whorled	7	20	40	White	Large	Long	30¾	47.0	53.8
102	Abundance	Wm. Rennie, Toronto, Canada	86	42	Whorled	7½	30	40	White	Med. lrg.	Med. l'ng	23¼	47.5	53 3
103	Ligowa	Wm. Rennie, Toronto, Canada	86	42	Whorled	7	95	70	White	Large	Med. sh't	25½	38.6	48.5
115	White Waverly	Wm. Rennie, Toronto, Canada	86	51	Whorled	10	90	70	White	Med. lrg.	Med. l'ng	24	42.3	....
98	Minnesota No. 202	Minnesota Experiment Station	87	42	Whorled	8	35	40	Lt Yel.	Medium	Med. l'ng	27	48.2	57.7
106	Egyptian	Wm. Rennie, Toronto, Canada	87	45	Whorled	7	80	60	White	Medium	Sh, plmp	22¾	38 6	44.8
99	World's New Black Beauty	Northrup, King & Co.	92	42	Whorled	7	95	30	Brown	Med. lrg	Long	23½	29.6	35.9
64	Negro Wonder	Farmers' Seed Co.	93	47	Whorled	8½	90	60	Brown	Medium	Medium	21½	19.9	....

101	Black Tartarian	Wm. Rennie, Toronto, Canada	93	44	Whorled	8	45	45	Brown	Med. lrg.	Med. l'ng	26¾	36.4	38.1
81	Race Horse	**Missouri Experiment Station	94	45	Whorled	9	85	35	White	Med. lrg.	Med. l'ng	28	49.3	46.3
39	White Russian	Minnesota Experiment Station	95	48	Whorled	10	60	15	White	Medium	Med. l'ng	33	55.8	
54	Selected Tartarian	North Dakota Exper. Station	95	50	Whorled	9½	70	15	White	Med lrg.	Long	33¼	63.9	
114	Improved White Russian	Oscar H. Will & Co	95	51	Whorled	10	85	30	White	Medium	Med. l'ng	30	52.9	
83	Tartarian	**Missouri Experiment Station	96	48	Whorled	9½	15	20	White	Medium	Med. l'ng	34½	56.6	50.3
104	New Zealand	Wm. Rennie, Toronto, Canada	96	45	Whorled	10	50	25	White	Med. lrg.	Med l'ng	33½	49.3	48.6

* Trace. ** The original seed of these varieties was grown at the North Dakota Station.

TABLE VI.—VARIETIES OF OATS GIVING LARGEST YIELDS IN 1902, GROUPED ACCORDING TO THEIR SEASON OF MATURITY.

Bulletin No.	Variety	Yield per acre—bushels	Weight per bu.—pounds	Harvest Season
84	Sixty Day	72.2	34	Early
46	Selected Black Beauty	44.3	27¼	Medium Early
42	U. S. No. 3	41.8	24	Medium Early
87	Big Four	41.8	24¾	Medium Early
119	20th Century	41.6	25¾	Medium Early
98	Minnesota No. 202	48.2	27	Medium
102	Abundance	47.5	23¼	Medium
100	Siberian White	47.0	30¾	Medium
115	White Waverly	42.3	24	Medium
54	Selected Tartarian	63.9	33¼	Late
83	Tartarian	56.6	34½	Late
39	White Russian	55.8	33	Late
114	Improved White Russian	52.9	30	Late

The earliest and latest maturing sorts produced best in 1902. The varieties having a medium season lodged and rusted worse than the others and gave greatly reduced yields. In 1901 the late varieties rusted worse and the medium sorts produced much the larger crop. Excepting No. 84, sixty day oats, which is very early and has made a remarkable yield, for the two seasons in which it has been grown, the varieties having a medium harvest season have given the largest average yields for the two trials as shown in Table VII.

TABLE VII.—VARIETIES OF OATS GIVING THE LARGEST AVERAGE YIELDS IN 1901 AND 1902, GROUPED ACCORDING TO THEIR SEASON OF MATURITY.

Bulletin No.	Variety	Weight per bu.—pounds	Yield per acre—bushels	Harvest Season
84	Sixty days	33	61.3	Early
87	Big Four	31⅛	50.2	Medium Early
85	Silver Mine	29⅜	50.1	Medium Early
89	Bow of Promise	29⅝	48.3	Medium Early
98	Minnesota No. 202	31¼	57.7	Medium
100	Seberian White	34¼	53.8	Medium
102	Abundance	29⅛	53.3	Medium
83	Tartarian	34¾	50.3	Late
104	New Zealand	35.5	48.6	Late
81	Race Horse	31.0	46.3	Late

It was stated in the twelfth annual report, page 55, that "varieties which have a medium harvest season are usually least affected by rust and adverse conditions." This was not the case in 1902; although the results of several trials seem to favor the varieties having a medium season. Early and late varieties are apt to go to extremes, some seasons appearing very hardy and producing enormous crops, while in others they are badly injured by rust and yield very poorly. The sorts with a medium harvest season produce more evenly each year and their average product has been equal to that of the late or early sorts. This variation in yielding qualities of varieties having different seasons of maturing is doubtless due to the weather conditions which prevail when the oats reach a certain stage of their growth.

VARIETIES OF BARLEY.

Nineteen varieties of barley were grown in the field trial in 1902. The land upon which the trial was made grew a crop of potatoes in 1901, and was not plowed for the barley. The ground was pulverized with the disc harrow May 15th and with the acme harrow just before seeding, May 23d. The grain was sown at the rate of nine pecks per acre, about two and one-half inches deep, and harrowed once after sowing. The stool was in good condition at the surface, but wet and heavy beneath. The seed was not treated for smut.

The grain was up well on all plots May 30th. On June 25th, the barley stood ten to twelve inches high, except the late varieties, which averaged eight inches high; it was an excellent stand, and had a dark green color. On July 12th the earliest sorts were well headed, while the varieties of medium season were just beginning to head. The barley made a very rank growth and all varieties lodged more or less, as noted in Table VIII. The straw was bright and almost free from rust. The heads were large and were generally well filled despite the lodging, and the crop proved to be above the average in the yield of grain. Harvest was begun August 4th and finished August 21st. The grain was threshed from the shock September 10th and was in good condition.

Table VIII. gives the record of the 1902 crop and includes the average yields of varieties which have been grown for two seasons.

TABLE VIII.—VARIETIES OF BARLEY—CROP OF 1902.

Bulletin No.	Variety	Where From	Days Maturing	Length of Straw—in.	Length of Head—in.	No. Rows per Head	Length of Beard—in.	Grain: Lodged—per ct.	Grain: Size of Berry	Grain: Color of Berry	Grain: Weight per bu.—pounds	Grain: Yield per Acre—bushels	Grain: Average for Two Crops—1901-1902
21	McEwan's Hulless	Park River, North Dakota	73	32	3½	2	4	60	Large	Brown	60	48.1	40.5
46	White Hulless	John A. Salzer Seed Co	76	33	2¼	6	*	95	Medium	Brown	56½	29.4	25.3
54	New White Hulless	Northrup, King & Co	76	30	2¼	6	*	100	Medium	Brown	55½	29.4	25.9
45	Great Beardless	John A. Salzer Seed Co	73	37	2½	6	*	10	Medium	Lt. Yel.	42½	49.3	41.9
49	Barnard's Minnesota No 28	Minnesota Experiment Station	72	40	2½	6	3½	15	Med. lrg.	Lt. Yel.	48½	56.3	47.0
51	Houston's Golden Queen, Minn. No. 100	Minnesota Experiment Station	72	38	2¼	6	4	10	Med. lrg.	Lt. Yel.	50	59.4	45.0
56	Common Six rowed	E. G. Schollander, Montpeliar, N. D	73	43	2⅔	6	3	25	Med. lrg.	Lt. Yel.	45½	57.6	....
44	Silver King	John A. Salzer Seed Co	74	36	2¾	6	3½	20	Med. lrg.	Lt. Yel.	48	55.3	46.8
47	Mansury's Minnesota No. 6	Minnesota Experiment Station	74	42	3	6	3½	T	Med. lrg.	Lt. Yel.	48	55.2	48.7
48	Minnesota No. 32	Minnesota Experiment Station	74	42	2¾	6	3½	T	Med. lrg.	Lt. Yel.	48	53.8	46.9
57	Mandscheuri	O. H. Will & Co	74	45	3	6	4	75	Med. lrg.	Lt. Yel.	45	57.6	....
50	Minnesota No. 87	Minnesota Experiment Station	75	42	2¾	6	3½	5	Med. lrg.	Lt. Yel.	47	54.8	47.6
52	Minnesota No. 105	Minnesota Experiment Station	75	41	2¾	6	3½	25	Med. lrg.	Lt. Yel.	47½	52.4	46.4
55	Mandscheuri	Wm. Rennie, Toronto, Canada	75	45	3	6	4	10	Med. lrg.	Lt Yel.	47½	55.7	50.4
25	Minnesota No. 6, Mansury	Minnesota Experiment Station	75½	44	3	6	3½	35	Med. lrg.	Lt. Yel.	48½	56.4	....
43	Moravian, U. S. No. 5793	Hungary, by U. S. Dept. of Agriculture	75½	35	3½	2	4	90	Med. lrg.	Lt. Yel.	49½	48.9	41.5
7	Two-rowed Mansury	N. B. A. G. Co	84	40	2¾	2	5	40	Large	Lt. Yel.	49½	57.1	....
19	Success	Minnesota Experiment Station	89	38	4	2	4	100	Large	Bleached white	51	46.4	40.6
53	Highland Chief	Northrup, King & Co	89	37	4	2	5	90	Large	Bleached white	48½	45.0	35.2

*Beardless. T Trace.

TABLE IX.—VARIETIES OF BARLEY GIVING LARGEST YIELDS IN 1902.

Bulletin No.	Variety	Yield per acre—bushels	Weight per bu. pounds	Harvest Season
51	Houston's Golden Queen	59.4	50	Early
56	Common Six-rowed	57.6	45½	Medium Early
57	Madscheuri	57.6	45	Medium Early
7	Two rowed Mansury	57.1	49½	Late
25	Mansury	56.8	48½	Medium Early
49	Barnards	56.3	48½	Early

TABLE X.—VARIETIES OF BARLEY GIVING LARGEST AVERAGE YIELDS IN 1901 AND 1902.

Bulletin No.	Variety	Weight per bu. pounds	Yield per acre—bushels	Harvest Season
55	Mandscheuri	46¼	50.4	Medium Early
47	Mansury	47	48.7	Medium Early
50	Minnesota No. 87	47	47.6	Medium Early
49	Barnards'	48¼	47.0	Early
48	Minnesota No. 32	47¼	46.9	Medium Early
44	Silver King	47	46.8	Medium Early

Trials by this station with Mansury six-rowed barley covering a period of nine years indicates that it is one of the best producing sorts. All of the bearded, six-rowed barleys are much alike in type and harvest season. The two-rowed barleys are usually late maturing sorts and are more variable in their yielding qualities than the six-rowed barleys. Hulless and beardless varieties yield less than the bearded types, and the station does not recommend them for general culture. No. 21 McEwans Hulless is a bearded type of barley, and the best producer of its class, which has been grown at this station.

EMMER OR SPELT.

Two trials of emmer or spelt were grown at this station in 1902. In the regular trial, the ground was the same as that already described for varieties of barley. The grain was seeded May 24th at the rate of about two and one-half bushels per acre, the drill being set to sow three bushels of barley per acre. With this rate of seeding and the favorable soil and season the grain made a very thick

stand and a rank growth. It lodged badly but it seemed to fill well and made a large yield.

Variety No. 2, Dakota grown seed, was ripe August 24th, and No. 5, which was seed furnished by the United States department of agriculture, was ripe August 26th. The grain was threshed from the shock September 10th. By accident the grain from the two plots was mixed and the separate yields could not be determined. The average yield was at the rate of 2,838 pounds (59 bushels) per acre, which is the largest yield recorded at this station. The average weight per measured bushel was thirty-eight pounds.

The above varieties of emmer or spelt were also sown on separate plots (about one acre in extent) on June 9th, on spring plowed land which grew wheat in 1901. This grain was nearly ripe at frost September 12th and was cut on that day, after having been slightly injured by frost. The yield of grain from these plots was determined and is given below:

Variety	Yield per acre—pounds	Weight per bu.—pounds
No. 2 North Dakota Emmer	2548½	37
No. 5 U. S. Dept. of Agriculture	2390½	34

In the above trial, the Dakota variety yielded best. In 1901 No. 5 gave the larger yield. The Dakota variety is one which was sent to the station by Mr. George A. Welch, Bismarck, N. D., in 1897, and has been grown in this climate for a number of years. It has usually outyielded the imported varieties at this station.

A more extended discussion of this new grain crop will be found in the twelfth annual report, page 60.

VARIETIES OF FLAX.

Seven varieties of flax were grown in the field trial in 1902. The land upon which the trial was made was planted with corn in 1901 and was not plowed for the flax. The ground was disc-pulverized May 14th and again May 23d, and was harrowed just before seeding. The seed was sown May 24th, one and one-half to two inches deep and at the rate of three pecks per acre, with the exception of No. 13, which was not sown until June 9th.

On May 31st the flax was coming up and made a good stand on all plots. The early flax was beginning to blossom July 12th. The crop was free from weeds. Harvest began August 5th and was completed August 21st except in the case of plot No. 13, which was not harvested until August 29th. The flax was cut with the binder, bound in bundles and shocked in long shocks. It was threshed from the shock September 11th, and was in good condition.

Table XI. gives the yield and other data recorded in the trial.

TABLE XI.—VARIETIES OF FLAX—CROP OF 1902.

Bulletin No.	Variety	Where From	Date Planted	Seed Sown per Acre—pecks	Days maturing	Length of Straw—in.	Number of bolls per Plant Avg.	Grain: Weight per bu.—pounds	Grain: Yield per acre—bushels
7	Russian	John A. Saltzer, Seed Co.....	May 24	3	90	24	32	56	25.6
9	Selected Russian.	Sel. No.7, bred at N.D.E.S....	May 24	3	87	28	30	55	24.1
10	Selected Russian.	Sel. No.7, bred at N.D.E.S...	May 24	3	86	29	24	55	25.9
11	Argentine	C. Hendricksen, Graft'n N.D.	May 24	3	87	23	18	55	22.4
12	Siberian..........	C. Hendricksen, Graft'n N.D.	May 24	3	74	34	18	55	14.6
13	U. S. 8524..........	U. S. Dept. of Agri..........	Jun. 9	3	81	30	12	54½	12.0
14	Common..........	Western N. D. Magill & Co..	May 24	3	85	30	24	54½	25.3
15	Sel. Riga Fiber...	*Sel. from Riga Fiber No. 5...	May 31	.	87	38	18	54½	13.4

*Originally from Russia. See 11th Annual Report. This variety was sown in a small plot in the nursery.

The season and method of culture, viz: (seeding the flax on corn land without plowing) were especially favorable to the flax crop in 1902 and an unusually heavy yield was produced. Selected Russian flax No. 10 produced the largest yield of seed, 25.9 bushels per acre, the heaviest yield of flax thus far recorded at this station. This variety of flax is a selection from Russian flax No. 7, and is the product of a single plant which produced 218 bolls, 6.2 grams of seed in 1899. The original seed was secured from the Salzer Seed company in 1899 and it seems to be an extra good strain of seed flax. It has yielded better than the common flax each season that a record has been kept. As an average for the crops of 1899 and 1900, the yields of common and of this Russian strain of flax compare as follows.

Russian flax No. 5.................... 17.5 bu. per acre
Common flax No. 6.................... 14.9 bu. per acre.

The Russian variety yielded a trifle better than No. 14 common western grown seed last season. The western seed with which it was compared last season was an excellent sample of flax, clean, bright and free from the "wilt" disease. The station has several bushels of No. 7 and No. 10 flax saved for seed and will begin to propagate these varieties for future distribution.

Nos. 12, 13 and 15 are fibre producing rather than seed yielding varieties. Selected Riga fibre flax is a selection from the Riga fibre flax No. 5. This flax produces very long straw with few branches and little seed. Local tests of the straw at Fargo indicate that the fibre is of an extra quality, and therefore superior to that of the ordinary seed flax for linen manufacture.

QUANTITY OF FLAX SEED TO SOW PER ACRE.

The experiment in sowing seed flax at different rates per acre has been carried on for three seasons. In 1902 the trial was made

on corn land prepared as already described under varieties of flax. All plots were seeded May 24th.

Table XII. gives the detailed results of the trial.

TABLE XII.—QUANTITY OF FLAX SEED TO SOW PER ACRE—CROP OF 1902.

Plot No.	Rate of Seed per acre—Pecks	Stand	Days Maturing	Height of Straw—in.	Weight per bu.—lbs.	Quality of Seed—per cent	Yield per acre—bu.
1	1	Good	87	27	55	93	22.2
2	1½	Good	86	27	54	90	21.5
3	2	Good	86	27	53½	90	19.8
4	2½	Good	87	27	53¼	90	18.0
5	3	Good	88	25	53¼	85	....
6	4	Good	88	23	54	88	....
7	5	Thick	87	24	53½	85	16.8
8	6	Thick	86	23	55¼	88	15.8

Plots 5 and 6 seeded at the rate of three and four pecks per acre respectively were on slightly lower ground. The crop on these plots was injured by the excessively wet season. The yields were not comparable to those from the other plots and are therefore not given in Table XII.

The results of the trial, so far as they can be used, seem to favor thin seeding. In the trials for 1900 and 1901 the results also favor sowing less than three pecks of seed per acre. The amount of seed to sow will doubtless depend somewhat upon the season and the condition of the soil at seeding time. When the season is dry or the soil is in poor tilth, a little more seed should be planted than would be sown in a favorable season or upon a soil which is in good condition.

DIFFERENT DATES OF SOWING FLAX.

As an experiment, flax was sown at different dates in 1902 as given in Table XIII. The land used for the trial was in corn in 1901 and was not plowed for flax, but was prepared with the disc and peg tooth harrow as already described under varieties of flax. The ground was cultivated each time just before the flax was sown and was thus made free from weeds. Western grown seed No. 14 was used in the trial. The flax was seeded with the Dowagiac shoe drill at the rate of three pecks of seed per acre, and was harvested and threshed as already stated for varieties of flax.

The results of the trial are given in table XIII.

TABLE XIII.—DIFFERENT DATES OF SOWING FLAX—CROP OF 1902.

Plot No.	Date Sown	Date Ripe	Days of Maturing	Stand	Length of Straw—in.	Weight per bu.—lbs.	Grade or Quality—per cent	Yield per acre—bu.
1	May 24....	Aug. 19....	87	Good......	27	53¼	90	18.0
2	May 30....	Aug. 28....	90	Good......	22	54½	95	15.8
3	Jun. 9.....	Sept. 10....	93	Good......	22	55	95	14.2
4	Jun. 17....	Sept. 12....	87	Good......	22	53½	85	17.1
5	Jun. 23....	Sept. 14....	83	Good......	22	55	83	17.2

The earliest sown flax gave the largest yield, but remarkably large yields from the late sowing were recorded. The late sown flax was not harvested until after the frost, September 12th, but it was nearly ripe at that date and was only slightly injured by the frost, and produced a good quality of seed. The ground upon which the flax was seeded had been cultivated up to the date of sowing and was in a perfect condition of tilth.

TRIALS IN SOWING FLAX AND WHEAT MIXED.

The experiment of sowing flax and wheat together was continued in 1902. The trial was made upon fall plowed land which had grown millet, flax and wheat in 1901, the plots of 1902 extending across those of 1901. In the 1902 experiment the wheat was sown at the rate of two, three and four pecks per acre, and the flax at the rate of one and one-half, two, and two and one-half pecks per acre. The flax was sown at two different dates, viz:—with the wheat and one week after the wheat was sown or just as it was coming up. The wheat was drilled east and west and the flax north and south. The wet season and the late seeding were unfavorable to the wheat, which made a rather poor stand. The flax was a comparatively good stand on all plots.

The plan of the experiment, together with the data obtained, are given in table XIV.

TABLE XIV.—FLAX AND WHEAT—CROP OF 1902—SHOWING PLAN OF EXPERIMENTS AND RESULTS.

Plot No.	Crop	Date Sown	Rate Per Acre—Pecks	Date Ripe	Stand—per cent	Height of Straw—inches	Yield per Acre—bushels	Weight per bu.—pounds	Grade
1	Wheat	May 24	4	Aug. 25	80	45	17.0	61½	1 N
	Flax	May 24	1½	Aug. 25	20	25	3.4	52	
2	Wheat	May 24	4	Aug. 25	75	44	16.7	61	1 N
	Flax	May 24	2	Aug. 25	19	24	3.5	52¾	
3	Wheat	May 24	4	Aug. 26	70	43	15.8	62¼	1 N
	Flax	May 24	2½	Aug. 25	18	23	3.2	53¼	
4	Wheat	May 24	4	Aug. 28	85	42	16.9	60¾	1 N
	Flax	May 30	1½	Aug. 30	15	22	2.6	50½	
5	Wheat	May 24	4	Aug. 28	80	41	15.1	60¼	1 N
	Flax	May 30	2	Aug. 30	18	22	2.6	52	
6	Wheat	May 24	4	Aug. 28	80	42	15.8	61	1 N
	Flax	May 30	2½	Aug. 30	20	22	2.6	50½	
8	Wheat	May 24	3	Aug. 28	40	36	10.8	61¼	1 N
	Flax	May 24	1½	Aug. 26	25	20	2.9	50¼	
9	Wheat	May 24	3	Aug. 28	50	38	12.3	60	1 N
	Flax	May 24	2	Aug. 26	30	21	3.5	51¾	
10	Wheat	May 24	3	Aug. 28	60	40	14.1	61¾	1 N
	Flax	May 24	2½	Aug. 26	30	22	3.8	52	
11	Wheat	May 24	3	Aug. 29	60	42	13.6	60	1 N
	Flax	May 30	1½	Aug. 30	25	23	3.6	50½	
12	Wheat	May 24	3	Aug. 29	65	42	14.2	61	1 N
	Flax	May 30	2	Aug. 30	30	23	4.0	51¼	
13	Wheat	May 24	3	Aug. 29	70	42	15.0	60	2 N
	Flax	May 30	2½	Aug. 30	25	23	3.8	50½	
15	Wheat	May 24	2	Aug. 29	65	42	15.1	61½	1 N
	Flax	May 24	1½	Aug. 26	35	23	5.3	53¼	
16	Wheat	May 24	2	Aug. 28	65	42	13.3	61½	1 N
	Flax	May 24	2	Aug. 26	35	23	5.0	53	
17	Wheat	May 24	2	Aug. 28	60	42	14.7	61	2 N
	Flax	May 24	2½	Aug. 26	35	23	6.0	54	
18	Wheat	May 24	2	Aug. 29	65	41	13.2	60¼	1 N
	Flax	May 30	1½	Aug. 30	30	22	4.2	52	
19	Wheat	May 24	2	Aug. 29	60	41	14.2	58½	1 N
	Flax	May 30	2	Aug. 30	30	22	4.5	57½	
20	Wheat	May 24	2	Aug. 29	60	41	13.2	60¼	1 N
	Flax	May 30	2½	Aug. 30	30	22	4.8	51	
7	Wheat	May 24	4	Aug. 24	78	42	13.6	60¾	2 N
14	Wheat	May 24	3	Aug. 29	85	44	16.0	60	1 N
21	Wheat	May 24	2	Aug. 29	75	42	13.2	60¼	1 N

The yields given in table XIV. were calculated from the weight of the clean grain from each plot, i. e.: after the two grains had been separated by the fanning mill. It will be observed that the wheat weighed and graded well. The flax was also of good quality. A small quantity of flax remained with the wheat after it was cleaned which probably increased the weight of the wheat per bushel.

Plots 7, 14 and 21 are the check plots upon which the wheat was seeded alone. Plot 7 is the check on plots 1 to 6 inclusive, plot 14, the check on plots 8 to 13 inclusive and plot 21 the check on plots 15 to 20 inclusive. The average yields from each set of plots are compared with the yield of the check plot as follows:

Plots Nos.	Yield per acre. 1902	
	Wheat—bu.	Flax—bu.
Plots 1 to 6, Flax with 4 pks. of Wheat	16.2	3.0
Plots 8 to 13, Flax with 3 pks. of Wheat	13.3	3.6
Plots 15 to 20, Flax with 2 pks. of Wheat	14.0	5.0
Plot 7, 4 pks. of Wheat alone	13.6	
Plot 14, 3 pks. of Wheat alone	16.0	
Plot 21, 2 pks. of Wheat alone	13.2	

The low yield from plot 7 and the low average yield of wheat from plots 8 to 13 may be due to a difference in the soil. It was observed at harvest time that the wheat had made the poorest stand and the poorest growth on these plots. The results, however, strongly favor sowing flax with wheat, since the plots seeded to wheat alone have yielded less wheat on the average than those seeded with wheat and flax.

	Yield per acre 1902.	
	Wheat—bu.	Flax—bu.
Average yield of Wheat and Flax	14.5	3.9
Average yield of Wheat alone	14.3	

The flax obtained was a clear gain in the above trial. If the wheat had been sown thicker, it would doubtless have yielded a little better. A plot of wheat sown at the rate of five pecks of seed per acre, on the same date, on corn and potato ground, (soil better adapted for wheat than that upon which the above trial was made) yielded twenty bushels of wheat per acre.

Comparing the yield of wheat and flax when each grain was sown at different dates, favors sowing both grains on the same date, as shown by the following tabular statement:

	Yield per acre 1902.	
	Wheat—bu.	Flax—bu.
Wheat and Flax sown on the same date	14.4	4.1
Flax sown six days later than the Wheat	14.6	3.5

The results of the 1901 trial were also strongly in favor of sowing both grains on the same date, while those of 1900 favored sowing

the flax a week later than the wheat. If the seeding is done early the flax may be sown a few days later than the wheat, but if the seeding is late both grains should be sown on the same date.

The amount of flax seed sown does not seem to have had much effect upon the stand or yield of flax. One and one-half pecks per acre is evidently enough to sow and a less quantity would do. Sowing flax with four pecks of wheat has given the largest yield of wheat and a little the largest combined yield of both grains, but sowing flax with two pecks of wheat has given the largest yield of flax and in the trial in 1902 the largest net profit, since the wheat is worth less per bushel than the flax.

In 1901 sowing three pecks of wheat and two pecks of flax on each acre gave the largest total yield of both grains. In 1900, four pecks of wheat sown with two pecks of flax gave the largest yield both of flax and wheat. The results of all trials seem to favor sowing three to four pecks of wheat with one and one-half to two pecks of flax. See if conclusions for several years warrant a general statement.

VARIETIES OF MILLET.

Twenty-one varieties of millet were sown in the regular field trial in 1902. Some of these varieties have been bred and grown at this station for several years, several were received from the United States department of agriculture and the others were from different seedsmen. The trial was made upon fall plowed land which had been in wheat the previous season. This ground had been very wet during the spring, but became sufficiently dry that it was cultivated with a spring tooth harrow May 24-26. The ground was worked again with a spring tooth harrow on June 9th. The soil was a little lumpy but fairly mellow and practically free from weeds when seeded June 9th and 10th.

The drill was set to sow three pecks of flax per acre for all varieties except Nos. 21, 22 and 23—the Japanese millets—which were seeded with the drill set to sow at the rate of four pecks (flax) per acre. The depth of sowing was two to two and one-half inches. All of the plots were harrowed once after sowing in order to kill weeds and level the ground. On account of the cool weather and cold soil, the seed germinated very slowly and the millet was only fairly well out of the ground on June 23d, two weeks after sowing. On account of the millet being so slow in starting, the weeds had a good chance to get under way and were in evidence even at harvest, as shown by table XV.

The majority of the varieties were allowed to mature and were cut for seed, in which case the yield of fodder was not determined. The Japanese millets failed to mature seed and were cut for hay as were also two other varieties which were not considered desirable for seed. Notes were made which indicate the comparative fodder value of several varieties. The results are given in table XV.

TABLE XV.—VARIETIES OF MILLET—CROP OF 1902.

Bulletin No.	Variety	Where From	Days Maturing	Height of Straw—in.	Length of Head—in.	Kinds of Heads	Color of Seed	Size of Seed	Weight per bu.—lbs.	Yield of Seed per Acre—bushels	Yield of Fodder per Acre—pounds
826	Hungarian..................	Northrup, King & Co.........	106	40	2¼	Foxtail........	Pale green..	Medium	42	15.1	
31	Selected North Dakota No. 1............	North Dakota Exper. Station	104	41	3	Foxtail........	Lt. yellow...	Medium	42	14.9	
32	Selected North Dakota No. 2............	North Dakota Exper. Station	106	46	4	Foxtail........	Lt. yellow...	Medium	40	8.3	
34	Common	Northrup, King & Co.........	99	36	3	Foxtail........	Lt. yellow...	Medium	51	34.7	
35	German (Northern grown seed)..........	Oscar H. Will & Co...........	98	30	2½	Foxtail........	Lt. yellow....	Medium	51¾	29.4	
36	†German (Southern grown seed).........	Northrup, King & Co.........	98	30	2¼	Foxtail........	....	....	....	....	‡4638
37	Siberian..................................	Northrup, King & Co.........	105	36	2⅝	Foxtail........	Lt. yel'sh gr.	Small ..	42	20.9	
38	Earliest Russian.......	Northrup, King & Co...	105	35	2½	Foxtail.......	Lt. yel'sh gr.	Small ..	42½	19.9	
11	Black Voronezh broom corn—U. S. 2795.	Russia, by U. S. Dept. of Agr.	100	42	9½	Lrg, l'ose br'm	Dark brown.	Large...	59½	29.2	
15	Tambo broom corn—U. S. No. 2794.......	Russia, by U. S. Dept. of Agr.	99	28	7	Open broom...	....	....	....	....	‡1483
16	Red Voronezh broom corn—U. S. No. 2796	Russia by U. S. Dept. of Agr.	97	28	5	Medium broom	Light red....	Very lrg	59	28.9	
17	Red Russian broom corn—U. S. No. 2797.	Russia, by U. S. Dept. of Agr.	99	28	7	Open broom...	Light red....	Large...	61¼	32.8	
18	Red Orenberg broom corn—U. S. No. 2960	Russia, by U. S. Dept. of Agr.	98	24	4	Close broom...	Light red....	Large...	60	25.2	
28	Hog.....................................	Northrup, King & Co.........	99	42	6	Medium broom	Lt. yellow...	Large...	59½	30.2	
29	White Ural broom corn—U. S. No. 5647..	Russia, by U. S. Dept. of Agr.	98	28	4	Close broom...	White	Large...	56½	25.5	
30	Yellow Ural broom corn—U. S. No. 5648.	Russia, by U. S. Dept. of Agr.	99	29	4	Lrg, close br'm	Light red....	Large...	58¼	26.9	
39	Russian broom corn.................	Russia, by U. S. Dept. of Agr.	99	32	8	Lrg, open br'm	Light red....	Large...	60¾	33.9	
40	Russian broom corn.....................	Russia, by U. S. Dept. of Agr.	99	28	7½	Lrg, open br'm	Light red....	Large. .	58¾	30.4	
21	Japanese barnyard grass (Panicun crus)	U. S. Dept. of Agriculture....	*	46	4	Cock's foot....	....	....	....	....	6555
22	New Japanese............................	Northrup, King & Co....	*	40	3½	Cock's foot ...	....	....	....	....	‡6848
33	Billion Dollar grass.....................	John A. Salzer Seed Co......	*	38	3½	Cock's foot....	....	....	....	....	‡5061

*Did not mature. †This plot was bought for Southern grown seed, but the crop was like that from Northern grown plants. ‡This plot was cut for hay Sept. 5. ‖This plot was cut for hay Sept. 12.

The broom-corn types average the best producers of seed, and the grain from them is larger and heavier and probably has greater feeding value than the seed from the fox-tail types.

Nos. 21, 22 and 33 (Japanese millet) did not mature seed in 1902, probably owing to the cold and backward season, but they made a good growth of fodder which was cut for hay. Japanese millet matured seed in 1901. This new millet is a rank grower, and produces a large yield of fodder. The crop last season was sown with the grain drill which was set to seed four pecks of flax seed per acre. That rate of seeding proved too thick for the best growth. This variety of millet stools heavily.

Nos. 31 and 32 are selected millets of the Chaetocloa glauca type which have been bred at this station. It is generally held by farmers that millet deteriorates when grown long in a northern climate, producing more seed but less fodder the longer it is grown from the northern seed. The above selections were made with the object of developing a North Dakota variety which would produce good crops of fodder and not deteriorate. North Dakota millet No. 2 is proving an excellent fodder variety. The yield of fodder was not taken last season, but it produced a rank leafy growth, with a small quantity of seed, eight and three-tenths bushels per acre.

For a further discussion of millet and millet seed, see the twelfth annual report, page 64.

VARIETIES OF FIELD PEAS.

Seven varieties of field peas were planted in 1902. The peas were sown May 26th with a Dowagiac grain drill, in drill rows six inches apart. The drill was set to sow two or three bushels of oats per acre, according to the size of the peas, which made the rate of seeding about two and one-half bushels of peas per acre. The land used for the trial grew a crop of wheat in 1901 and was fall plowed. The ground was prepared with a spring tooth harrow just before seeding.

One-half of each plot was cut for fodder August 29th. The stage of maturity and length of vines of each variety was noted at that date and the data is given in table XVI. The other half of each plot was cut for seed. The exact date of maturing of each variety was not noted, but all of the plots were cut at one date, September 10th, and were allowed to cure in the window. The peas were threshed October 10th with the ordinary grain separator which split the peas badly.

The yields and other data obtained are given in table XVI.

TABLE XVI.—VARIETIES OF FIELD PEAS.—CROP OF 1902.

Bulletin No.	Variety	Where From	Rate Seeded per Acre—bu.	Stand	Length of vines—ft.	Stage of Maturity August 29	Color	Size	Form	Weight per bu.—lbs.	Yield per acre—bu.	Fodder Yield per Acre—lbs.
1	Oddfellow............	Wm. Rennie, Tor. Can	2½-3	Thin.....	3½	Almost ripe.........	Lt. Yellow	Large ..	Cylindrical..	69	27.2	*
2	Lupine or Grass Peas.	Wm. Rennie, Tor. Can	2½-3	Excellent	4½	Blossoms and pods..	Lt. Yellow	Small...	Angular......	67	24.7	8267
3	Gipsy.................	Wm. Rennie, Tor. Can	2½-3	Thin.....	1¼	Nearly ripe..........	Green	V'ry lrg.	Oval, 'rinkled	....	....	4354
4	Yellow Can. Field....	Northrup King & Co.	2½-3	Good.....	5	Poded, half ripe....	Lt. Yellow	Medium	Sm'th, round	67	25.2	*
5	Golden Vine Field....	Northrup King & Co.	2½-3	Excellent	6	Blossoms and pods..	Gold'n Yel.	Medium	Sm'th, round	68	28.9	*
6	Green Canada Field..	Northrup King & Co.	2½-3	Excellent	5	Fully podded	Green	Small...	Sm'th, round	68½	23 9	*
7	Scotch Field..........	Northrup King & Co.	2½-3	Excellent	5	Fully podded........	Green	Medium	Sm'th, round	68	25.9	*

* A wind storm blew the fodder of these plots together so that separate yields could not be determined. The average yield was 6369 lbs. per acre.

The Golden Vine variety gave the largest yield of peas and also (judging from observation) of fodder, although the separate yields from the several plots could not be determined as noted above. Lupine or so-called grass peas make a good fodder and gave a very large yield in this trial.

A TRIAL OF DIFFERENT CROPS FOR FODDER.

On June 17th, 1902, corn, millet, peas, oats, barley and emmer were sown alone or in combination as a comparative fodder trial. The seeding was done with a grain drill. All crops were sown in drills six inches apart and were harrowed once immediately after sowing, but received no further cultivation. A plot of corn was also planted on the same date in drill rows three and one-half feet apart and cultivated for a comparison with the sowed corn.

All crops made a good stand and a fair growth. Each crop was cut as it reached the proper stage of maturity to make good fodder. The corn was frosted September 12th and was not cut until several days later. The plan of the experiment with the yields and other data obtained are given in table XVII.

TABLE XVII.—A TRIAL OF FODDER CROPS. PLANTED JUNE 17, 1902.

Plot No.	Name of Fodder	Rate of Seeding per Acre	Date Cut	Stage of Maturity When Cut	Height—inches	Yield per Acre Cured Fodder—pounds	Moisture in Air Dry Fodder—per cent	Yield per Acre Chemically Dry Fodder - pounds
1	Yellow Canada field peas	Pecks 10	Aug. 26	Blossoms and pods	54	4928	12.47	4313
2	Peas and oats	Peas—pecks 4	Sept. 5	Hard	50			
		Oats—pecks 8		Milk	48	5794½	15.52	4895
3	White Russian oats	Pecks 12	Sept. 5	Milk	51	5575	16.54	4471
4	Barley and oats	Barley—pecks 6	Aug. 26	Hard dough	32			
		Oats—pecks 6		Blossom	47	5186	15.13	4401
5	Mansury barley	Pecks 10	Aug. 15	Milk	32	3929	13.02	3417
6	North Dakota emmer	Pecks 11	Aug. 26	Early milk	40	5512	16.72	4590
7	German (Northern grown seed) millet	Pecks 3	Aug. 15	Fully headed	30	4860	16.13	4076
8	Millet and oats	Millet—pecks 1½	Aug. 26	Nearly ripe	30			
		Oats—pecks 6		Blossom	50	5858	16.33	4901
9	North Dakota No. 100 corn, 6-in. drills	Drill set for 2½ bu. oats	Sept. 17	Silk and milk	60	4861	12.35	4260
10	Corn, 42-in. drills, cultivated	Drill set for 2½ bu. oats	Sept. 17	Silk and milk	72	2105	12.35	1843

Sowing one and one-half pecks of millet and six pecks of oats together gave the largest yield of air dry fodder. The next largest yield was taken from plot 2, which was seeded with four pecks of peas and eight pecks of oats. Oats seeded alone stood third in yield. The oats rusted some, which slightly injured the quality of the hay, but in quantity of fodder produced oats and oat mixtures stand first.

Emmer also produced a large yield of hay of good quality. When sown thick the straw of this grain is slender and leafy and makes good hay.

In sowing two or more grains together for fodder, care should be taken that their periods of maturing are nearly alike. In the above trial, the millet and barley ripened too early to be sown with White Russian oats. When the fodder was cut the barley and millet were already too mature, while the oats had not yet reached a sufficient stage of maturity to make the best hay. Emmer and peas or emmer and oats would mature well together, or if barley or millet is used, choose later varieties, or an early variety of oats. Corn is a standard fodder, although when sown so late as in the above trial, its product and feeding value may be inferior to that of other fodders.

No comparative feeding trials were made with the above fodders. They are all readily eaten by stock, when saved in good condition. Samples of each fodder were taken from the field when the crop was harvested and analyses of each sample were made under the direction of Professor E. F. Ladd, station chemist, his report of which is herewith given.

In the following table the numbers given for each analysis correspond with the plot number given in the preceding table XVII., where a full description is given of the fodder and method of seeding:

	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8
Water	10.88	11.07	11.24	9.56	10.02	9.68	8.63	11.40
Ash	4.99	7.91	8.12	6.63	6.12	8.54	8.35	8.05
Fat	1.95	3.20	3.48	2.10	2.52	2.13	2.60	2.09
Crude fiber	24.24	29.00	27.56	27.17	19.24	30.43	30.14	31.11
Proteids	14.54	10.85	9.26	9.56	10.93	9.73	10.93	8.12
Nitrogen free extract	43.41	37.97	40.34	44.98	57.17	30.49	39.32	39.23
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

In the case of samples 9 and 10 being corn on fall and spring plowing no determination was made of amount of water, hence the results below are for water free substance:

	Water Free	
	No. 9	No. 10
Ash	5.35	5.63
Fat	2.60	2.53
Crude fiber	25.44	24.97
Proteids	10.50	9.12
Nitrogen free extract	56.11	57.75
	100.00	100.00

From the tabular statement of the results from chemical analyses submitted herewith by Professor Ladd, it will be seen that the nitrogen free extract (the starchy material in feed stuffs) runs high in sample No. 9 (which is corn planted in six inch drills) and from table XVII. it will be seen that the gross yield was a little over two tons per acre. The above facts taken together indicate that the plat of land containing the corn probably yielded more pounds in food value i. e. digestible matter per acre than any other crop in the series.

Plot No. 1, which was sown to Canada field peas, made a little heavier gross yield of hay or fodder and while it yielded less than four-fifths as much total protein (muscle forming food) fat and nitrogen—free extract (starchy food) per acre the extra percentage of protein (muscle forming matter) probably makes it much nearer than four-fifths as valuable for feed.

Barley and oats mixed, (plot 4), millet and oats mixed, (plot 8), peas and oats mixed, (plot 2), and barley and oats mixed, (plot 4), differ little when the net feed value to the animal is considered.

Oats alone (plot 3) and spelt or emmer alone (plot 6) are a little poorer than the other things in the list described above.

Spelt or emmer is noticeably better than millet alone (plot 7) in this trial.

Corn grown in 42-inch drills (plot 10) ranks far below all of the other crops in the trial as might naturally be expected to result from cutting the corn at such an early stage of growth viz: at the silking time.

In considering the above discussion and statement of facts it should be remembered that the trial covers a single season only and hence cannot be taken as final or conclusive.

VARIETIES OF POTATOES.

Twenty-seven varieties of potatoes were planted in the field trial in 1902. Potatoes were planted May 31st on spring plowed land, (wheat stubble.) The ground was very wet when plowed and remained wet and cold for several weeks after planting. The tubers

were cut with two to four eyes to the piece, and one or two pieces were planted in hills two and one-half feet apart, in rows three feet and eight inches apart. Fifteen pounds of seed were planted on a row four hundred and forty feet long. Furrows about four inches deep were made with the plow and the potatoes were planted by hand and covered with the corn cultivator.

The field was harrowed twice before the potatoes came up and the crop was well cultivated and kept free from weeds during the season. The potatoes made a poor stand and were not a good crop. Nos. 43 to 100 inclusive were seed from the 1901 crop grown at the station farm. The seed was kept in too warm a cellar and the tubers were badly sprouted and wilted when planted. These varieties made the poorest stand. Nos. 102 to 110 inclusive were received direct from the seedsmen in the spring of 1902, and were better in quality and stronger seed than the home grown tubers, as shown by the better stand.

Most of the vines were green or partly green at frost, Sept. 12th, although when the tubers were dug, October 13th and 14th, they appeared firm and well ripened and were of good quality.

Table XVIII gives the results of the trial.

TABLE XVIII.—VARIETIES OF POTATOES—CROP OF 1902.

Bulletin No.	Variety	Where From	State of Maturity at Frost Sept. 12	No. Hills Harvested	Average Size of Tubers	Shape	Color	Depth of Eyes	Fingers & Toes—pr ct	Flavor—per cent	Mealiness—per cent	Marketable—per ct.	Small—per cent	Scabby—per cent	Yield per Acre—bu.
43	Carman No. 1	Walter Burpee & Co	Very green	154	Small	Oblong	Wh. russet	Medium	0	70	75	47	14	39	120.9
47	Rural N. Yorker No. 1	Walter Burpee & Co	Green	32	Medium	Flat, oval.	White	Shallow.	0	90	90	82	18	0	73.3
48	Six Weeks	J. A. Salzer Seed Co	¼ Ripe	70	Med. lrge	Oblong	Red russet	Med. shll	1	95	96	10	15	75	98.9
49	Early Ohio	Exper. Sta. Farm	½ Ripe	157	Med. lrge	Oblong	Red russet	Medium	1	95	98	11	11	78	103.1
50	World's Fair	L. L. Olds, Clinton, Wis	Green	53	Med. sm'l	Flat, oval	White	Shallow	0	80	85	54	13	31	75.0
55	Freeman	Northrup, King & Co	Very green	133	Medium	Flat, oval	White	Shallow	0	75	75	81	10	9	83.4
69	Hundredfold	J. A. Salzer Seed Co	Very green	53	Medium	Oval	Wh. russet	Shallow	0	70	75	68	8	24	72.3
82	Salzer's Good Times	J. A. Salzer Seed Co	Green	55	Medium	Round, ovl	Deep red	Med. de'p	0	90	85	25	26	49	54.8
84	All the Year Round	J. A. Salzer Seed Co	½ Ripe	84	Med. lrge	Oblong	Red russet	Medium	0	85	95	20	14	66	76.6
85	Sunlight	J. A. Salzer Seed Co	Green	21	Medium	Long, oblg	Lt. yellow.	Medium	0	85	85	30	22	48	71.9
86	Daughter of Rose	J. A. Salzer Seed Co	Very green	74	Med. lrge	Long, oblg	Rose rd rus	Med. de'p	5	80	85	36	14	50	101.7
87	Earliest Six Weeks	Wm. Rennie, Toronto	½ Ripe	199	Med. lrge	Obl'ng, ovl	Red russet	Medium	0	95	98	20	11	69	76.5
90	Rose of the North	Wm. Rennie, Toronto	Nearly green.	120	Medium	Long, oblg	Rose rd rus	Medium	3	85	90	40	16	44	110.0
95	Banner	L. L. Olds, Clinton, Wis	Green	108	Medium	Flat, oval	White	Med. shll	0	65	65	93	7	0	79.9
96	Ham'ond's Wond'rful	L. L. Olds, Clinton, Wis	Nearly green.	150	Medium	Long, oblg	Russet	Shallow	0	90	85	88	12	0	105.4
97	Maule's Commercial	L. L. Olds, Clinton, Wis	Very green	58	Large	Oblong	Red	Deep	0	80	75	90	16	0	86.1
98	Livingstone	L. L. Olds, Clinton, Wis	Very green	52	Medium	Ovl, obl'ng	Lt. russet.	Medium	0	75	80	68	0	32	78.9
102	White Mountain	Ireland, by Wm. Rose, Fargo, N. D	Very green	174	Med. sm'l	Ovl, obl'ng	White	Med. de'p	1	70	70	42	16	42	55.2
103	Early Harvest	Wm. Rennie, Toronto	Green	52	Med. lrge	Long, oblg	White	Med. de'p	0	75	80	45	13	42	135.4
104	Quick Crop	Wm. Rennie, Toronto	½ Ripe	120	Medium	Long, oblg	Lt. red rus	Medium	5	80	85	37	13	50	135.3
105	Astonisher	L. L. May & Co	¼ Ripe	106	Med sm'l	Long, oblg	White	Medium	0	85	85	40	14	46	105.9
106	Early Rose	L. L. May & Co	Green	115	Med. lrge	Long, oblg	Rose rd rus	Medium	3	70	80	46	12	42	143.1
107	Early Fortune	L. L. May & Co	Green	134	Medium	Long	Red russet	Med. de'p	2	85	80	27	17	56	111.3
108	Early Minnesota	L. L. May & Co	½ Ripe	165	Med. lrge	Oblong	Red russet	Medium	0	90	90	24	12	64	110.2
109	Algoma	L. L. May & Co	¼ Ripe	162	Med. sm'l	Oblong	Red russet	Medium	3	93	95	25	20	55	82.7
110	May's Netted Gem	L. L. May & Co	Very green	161	Med. lrge	Med. long.	Deep rus't.	Shallow	0	85	90	74	17	9	125.3
111	Taylor's Best	G. Taylor, Bathgate, ND	Very green	117	Very l'rge	Oblong	Red	Very deep	0	90	85	88	4	8	76.7

NOTE.—To determine the percentage of large potatoes, add together the per cent marketable and the per cent sc .

Most of the potatoes were badly affected by scab. The seed received no treatment before planting. Those varieties showing little or no scab were Rural New Yorker No. 1, Banner, Hammond's Wonderful, Maule's Commercial, May's Netted Gem and Taylor's Best. The four varieties giving the largest yield last season in the order of their production were Early Harvest, Quick Crop, May's Netted Gem and Carman No. 1. Those varieties which were most mature at frost, September 12th were Early Ohio, All the Year Around, Earliest Six Weeks, Quick Crop and Early Minnesota.

ROOT CROPS.

A trial of different varieties of roots was begun in 1901 and continued in 1902. Five varieties of mangels, one variety of sugar beets, five varieties of carrots and seven varieties of turnips and rutabagas were planted in the variety trial in 1902. The seed was all planted June 10th with the Dowagiac shoe drill in rows two and one-half feet apart. The drill was set to sow the different seeds as follows: Mangels and sugar beets, three bushels of oats per acre, carrots, four pecks of flax per acre; turnips and rutabagas, two pecks of flax per acre. The rates of sowing indicated planted about twenty pounds of beet seed and nine pounds of carrot, and turnip seed per acre. Less seed may be safely sown on well prepared land in favorable seasons. The beets were planted about three inches deep and the carrots about two inches deep. In the above trial the land was spring plowed and well prepared with the acme harrow and clod crusher.

All varieties came up well and made an excellent stand. The crop was cultivated and kept free from weeds. On July 9th and 10th the mangels and turnips were thinned to four and six inches apart in the row. On July 18 and 19 the carrots were thinned to three and four inches apart in the row. The roots were pulled October 15th-17th.

Table XIX gives the results of the trial.

TABLE XIX.—VARIETIES OF ROOTS—CROP OF 1902.

Bulletin No.	Variety Name	Kinds of Roots	Where From	Roots: Size	Roots: Color	Roots: Form	Yield per Acre Tons	Yield per Acre Lbs.
4	Mammoth White Intermediate	Carrot	Wm. Rennie, oronto	Large	White	Half long	11	780
5	Cooper's Yellow Intermediate	Carrot	Wm. Rennie, Toronto	Medinm	Yellow	Half long	4	753
6	Large White Vosages	Carrot	L. L. May & Co	Med. to large	White	Long	5	48
7	Yellow Giant	Carrot	L. L. May & Co	Medium	Yellow	Long	6	1,789
8	Mastodon	Carrot	Northrup. King & Co	Med. to large	White	Long	6	1,717
8	Selected White Globe	Turnip	Wm. Rennie, Toronto	Medium	White	Globe	13	619
9	Red Globe	Turnip	Wm. Rennie, Toronto	Medium	Red	Globe	7	149
10	Purple Top Mammoth	Turnip	Wm. Rennie, Toronto	Large	Red	Globe	14	58
11	Monarch Giant	Rutabaga	Wm. Rennie, Toronto	Medium	Yellow	Globe	11	1,505
12	Sweet German	Rutabaga	Northrup, King & Co	Large	White	Globe	10	1,583
13	Prizewinner	Rutabaga	Northrup, King & Co	Med. to large	Yellow	Globe	9	1,010
14	Hurst's Monarch	Rutabaga	Northrup, King & Co	Med. to large	Yellow	Globe	7	1,588
10	Giant Sugar	Mangel	Wm. Rennie, Toronto	Large	Pink	Long	14	1,736
11	Mammoth Long Red	Mangel	L. L. May & Co	Large	Red	Long	15	1,415
12	Red Globe	Mangel	L. L. May & Co	Large	Red,	Globe	7	1,588
13	Golden Tankard	Mangel	L. L. May & Co	Medium	Yellow	Globe	15	1,655
14	Champion Yellow Globe	Mangel	L. L. May & Co	Med. to large	Yellow	Flat h'lf globe	13	139
3	Kleinwanzlebener	Sugar beet	L. L. May & Co	Med. to small.	White	Med. to long	8	787

In the above trials the yields favor Mammoth White Intermediate Carrots, Purple Topped Mammoth Turnips, Monarch Giant Rutabagas and Mammoth Long Red and Golden Tankard Mangels.

TABLE XX.—THE TRIAL OF VARIETIES OF ROOTS MADE IN 1901 GAVE RESULTS AS FOLLOWS:

Bulletin No.	Variety Name	Kinds of Roots	Where From	Roots				
				Size	Color	Form	Yield per Acre Tons	Lbs.
1	Victoria	Carrot	Northrup, King & Co	Medium	Yellow	Long	5	410
2	Mastodon	Carrot	Northrup, King & Co	Med. to large.	Yellow	Long	7	583
3	Mammoth Intermediate Wh. Field	Carrot	Wm. Rennie, Toronto	Large	White	Long	5	
1	Green Top	Rutabaga.	Wm. Rennie, Toronto	Med. to small.	White	Globe	4	1,111
2	Hurst's Monarch	Rutabaga.	Northrup, King & Co	Medium	Yellow	Globe	5	833
3	Carter's Hardy	Rutabaga.	Northrup, King & Co	Medium	Yellow	Globe	7	166
4	Sweet German	Rutabaga.	Northrup, King & Co	Med. to large.	White	Globe	9	333
5	Rennie's Kangaroo	Rutabaga.	Wm. Rennie, Toronto	Med. to large.	Yellow	Globe	5	333
6	White	Rutabaga.	Wm. Rennie, Toronto	Large	White	Globe	8	250
7	Prizewinner	Rutabaga.	Northrup, King & Co	Large	Yellow	Globe	9	802
1	Buckbee's Mastodon	Mangels	H. W. Buckbee Seed Co	Large	Red	Long	8	458
2	Taber's Gatepost	Mangels	Northrup, King & Co	Med. to large.	Yellow	Globe	9	1,791
3	Half Sugar	Mangels	Wm. Rennie, Toronto	Large	Pink	Long	14	125
4	Golden Tankard	Mangels	Wm. Rennie, Toronto	Medium	Yellow	Globe	6	500
5	Red Globe	Mangels	Wm. Rennie, Toronto	Med. to large.	Red	Globe	4	1,543
6	Giant Yellow Globe	Mangels	Wm. Rennie, Toronto	Med. to large.	Yellow	Flat globe	7	1,625
7	Giant Yellow Half Long	Mangels	Wm. Rennie, Toronto	Med. to large.	Yellow	Long	10	1,041
8	Perfection Mammoth Long	Mangels	Wm. Rennie, Toronto	Med. to large.	Red	Long	7	583
9	New Danish Improved	Sugar beet	Wm. Rennie, Toronto	Medium	Pink	Med. to long.	6	1,958
1	U. S. No. 5769	Sugar beet	U. S. Dept. of Agriculture	Med. to small.	White	Half long	6	1,333
2	U. S. No. 5770	Sugar beet	U. S. Dept. of Agriculture	Med. to small.	White	Half long	7	583

The 1901 crop was planted and cared for in the manner already described for the crop of 1902. Many of the varieties in this trial did not make a good stand, which accounts for the poorer yields. The Mastodon proved to be the best yielding carrot in 1901, the Prize Winner, the best producing rutabaga and the Half Sugar, the largest yielding mangel. Roots, especially mangels, do not grow very large in our soil, the soil is probably a little too heavy and often too compact for the best and largest growth of root crops.

VARIETIES OF FIELD BEANS.

The trial of varieties of beans in 1901 was a complete failure. The beans were planted at the proper time and cared for as usual, but pods did not form on the vines except to a limited extent and the vines remained green and growing until frost—the crop was not harvested.

In 1902 eight varieties of beans were planted in the field trial. The ground was similar and prepared in the same manner as already described for root crops. The beans were planted June 10th in drill rows two and one-half feet apart. Nos. 8 and 14 are large beans and were planted by hand, all others were planted with the grain drill which was set to sow two and one-half to three bushels of oats per acre, according to the size of the beans. At this rate of sowing about twenty-four quarts of beans were planted per acre.

The crop was well cultivated and hoed and kept free from weeds.

None of the varieties were fully ripe at frost, September 12th. The beans were pulled and threshed in October and the yields were calculated as given in Table XXI, being the total product of the crop, including both good and poor beans. The percentage of good beans is noted in the table and indicates the extent of the damage by frost and the relative stage of maturity of the beans at that date.

White Wonderfield beans gave the largest total yield, and is a remarkable producer, but it was not so mature as other varieties at frost and produced only a small percentage of good beans. The Brown or Swedish variety stands at the head in the production of marketable beans last season and the Dewey Navy stands second. The latter was the nearest maturity at frost of any of the varieties in the trial.

VARIETIES OF CORN.

Forty-four varieties of corn were planted in the trial of varieties in 1902. The list included Nos. 26, 41 and 100 which have been grown at this Station for several seasons; four varieties, Nos. 82, 114, 116 and 119 were grown in the 1901 trial and the seed was saved from that crop, while thirty-one varieties were received last spring direct from the seedsmen and others mentioned in Table XXII.

TABLE XXI.—VARIETIES OF BEANS—CROP OF 1902.

Bulletin No.	Variety	Where From	Stage of Maturity at Frost, Sept. 12	Height of Vines—inches	Beans				
					Color	Size	Form	Quality—per cent	Yield per Acre—bu.
7	Dewey Navy	Oscar H. Will & Co.	¾ ripe	12	White	Med. to sm.	Oval	75	9.6
8	Red Kidney	Northrup, King & Co.	¼ ripe	11	Red	Very large.	Kidney	25	5.2
9	Brown or Swedish	Northrup, King & Co.	⅔ ripe	8	Brown	Med. to lrg	Ovl. obl'ng	66	12.0
10	California Wonder	Northrup, King & Co.	½ ripe	16	White	Med. to sm.	Ovl. obl'ng	50	6.8
11	Choice Navy	Northrup, King & Co.	⅓ ripe	14	White	Med. to sm.	Ovl. obl'ng	33	6.4
12	White Wonder Field	John A. Salzer Seed Co.	⅓ ripe	18	White	Medium	Oval	37	14.8
13	Improved Tree	John A. Salzer Seed Co.	⅔ ripe	13	White	Medium	Oval	66	7.6
14	Boston Favorite	John A. Salzer Seed Co.	½ ripe	15	Br. mot'led	Very large.	Kidney	37	8.8
15	*Broad Windsor	Northrup, King & Co.	.....	..	.....	.....	.....	..	....

*Immature; no pods formed.

The corn was planted May 26th and 27th on fall plowed land which had been in wheat the year previous. The ground was prepared with the spring tooth and smoothing harrows and was in fair condition at the surface but wet and cold beneath when planted.

On account of the cold weather and the wet, cold soil, the corn did not germinate well and many varieties made a poor stand. The corn was planted with a Hay's Junior drill planter, in drill rows three feet and eight inches apart. The planter was set to drop one kernel every ten to twelve inches. The depth of planting was two to three inches. All plots were harrowed May 28th and again June 3rd. It was noted that some corn was coming up on the latter date. The corn was cultivated as follows:

June 19-20—harrowed twice with Halleck's weeder.

June 27-28—cultivated with the Deere Surface (blades) cultivator.

July 2-3—cultivated with Hay's Spring Tooth (8 shovels) cultivator.

July 10-11—cultivated with the Deere Surface (blades) cultivator.

July 21-22—cultivated with the Sunshine (6 shovels) cultivator.

July 29-30—cultivated with the Deere Surface (blades) cultivator.

All corn was hoed July 25th to 29th. The weeds grew very freely during the latter part of the season and it was found necessary to continue the cultivation later than usual on that account, and also because of the backward condition of the corn. On Juiy 12th it was noted that the standing height of the corn was eighteen to twenty-one inches, (knee high), or thirty inches to the tip of the leaves.

It was a week behind in growth July 12th last season and the unfavorable corn weather in August (cool nights) retarded the maturing of the crop still further, so that the earliest varieties had not reached full maturity September 12th, the date of the first killing frost.

Because of the poor stand and immature state of the corn at frost no yields were taken. The data recorded is given in Table XXII.

TABLE XXII.—VARIETIES OF CORN—CROP OF 1902.

Bulletin No.	Variety	Class	Where From	Stand	Stage of Maturity at Frost, September 12	Average Number of Stalks per Hill	Height of Stalks —feet	H'ght of Ears—in.
26	Selected Northwestern Dent	Red Dent	North Dakota Experiment Station	Very good	Dough to hard	2 to 3	5½	24
41	Selected Red Acme	Red Dent	North Dakota Experiment Station	Good	Dough to hard	1 to 2	5	20
82	French's Squaw	Flint	N. S. French, LaMoure N. D	Good	Mostly hard	3	4¼	12
100	North Dakota	Yellow Dent	North Dakota Experiment Station	Good	Dough to hard	1 to 2	6	24
114	S. D. Early White Dent	White Dent.	G. N. Dawson, Havana, N. D	Fair	Dough	2 to 3	5½	26
116	Dawson's Cross Bred	Red Dent	G. N. Dawson, Havana, N. D	Good	Dough	1 to 2	5	20
119	Golden Dent	Yellow Dent	Walter Russell, Fargo, N. D	Very good	Dough to hard	1 to 2	6	33
121	Triumph	Yellow Flint	Oscar H. Will & Co	Poor	Milk to dough	3 to 5	6½	24
122	Yellow and White Fodder	Flint	Oscar H. Will & Co	Fair	Mostly hard	3 to 6	4½	10
123	Gehu	Yellow Flint	Oscar H. Will & Co	Very fair.	Mostly hard	3 to 5	4	8
124	Northwestern Dent	Red Dent	Oscar H. Will & Co	Fair	Hard	1 to 4	5	18
125	Will's Acme	Red Dent	Oscar H. Will & Co	Fair	Milk to dough	1 to 3	6½	30
126	Will's Dakota	White Flint.	Oscar H. Will & Co	Fair	Dough to hard	3 to 6	4½	8
127	Compton's Early*	Yellow Flint	William Rennie, Toronto	...	...	...	...	..
128	Northern Prolific	Yellow Flint	William Rennie, Toronto	Good	Silk to milk	3 to 5	6¾	36
129	Extra Early Dakota Queen	Yellow Dent	L. L. May & Co	Good	Silk	1 to 2	8	48
130	Pride of Canada	Yellow Flint	L. L. May & Co	Good	Silk to milk	3 to 5	6¾	24
131	Sanford's White Flint	White Flint.	L. L. May & Co	Good	Silk to milk	1 to 2	7	30
132	Champion White Pearl	White Dent.	L. L. May & Co	Good	Silk	1 to 3	8	54
133	King of the Earliest	Yellow Dent	L. L. May & Co	Good	Milk	3 to 6	7¼	42
134	White Flint	White Flint.	Northrup, King & Co	Fair	Silk to milk	1 to 3	6½	28
135	Red Cob Fodder	White Dent.	Northrup, King & Co	Poor	Silk	1 to 3	8	54
136	Giant Fodder	White Dent.	Northrup, King & Co	Fair	Silk	1 to 3	8	48
137	Special White Fodder	White Dent.	Northrup, King & Co	Fair	Silk	3 to 5	7	36
138	Stowell's Evergreen Sweet	Sweet	Northrup, King & Co	Poor	Silk	1 to 2	5¾	28
139	Rustler Early White Dent	White Dent.	Northrup, King & Co	Fair	Milk to dough	3 to 5	7	36
140	Improved King Philip	Red Flint	Northrup, King & Co	Good	Milk to dough	1 to 2	6¾	26
141	North Dakota Dent	Yellow Dent	Northrup, King & Co	Fair	Milk to dough	2 to 3	7	42
142	Northwestern Dent	Red Dent	Northrup, King & Co	Fair	Dough	1 to 3	6½	30
143	Minnesota King	Yellow Dent	Northrup. King & Co	Fair	Milk to dough	3 to 6	6½	30
144	Early Minnesota Sweet	Sweet	Northrup, King & Co	Poor	Milk to dougn	1 to 3	5½	18
145	Huron Early Dent	Yellow Dent	Northrup. King & Co	Fair	Milk	3 to 5	7	42
146	Mercer	Yellow Flint	Nortnrup, King & Co	Fair	Milk to dough	3 to 5	6¼	30
147	Smut Nose	Yellow Flint	Northrup, King & Co	Fair	Milk to dough	3 to 5	6	28

148	North Dakota	Yellow Flint	Northrup, King & Co	Good	About ripe	3 to 5	4	10
149	Triumph	Yellow Flint	Northrup, King & Co	Good	Milk to dough	3 to 5	6	20
150	Longfellow	Yellow Flint	Northrup, King & Co	Fair	Milk to dough	3 to 5	5½	24
151	Pride of the North	Yellow Dent	Northrup, King & Co	Poor	Milk to dough	1 to 2	5¾	36
152	Early Ripe Fodder	White Dent.	Salzer Seed Co	Poor	Mostiy hard	1	4	15
153	Salzer's Tripple Income	Yellow Dent	Salzer Seed Co	Poor	Mostly milk	1 to 2	6½	42
154	Parker's Mammoth	Yellow Dent	E. F. Parker, Peoria, Ill	Fair	Silk	1 to 2	7	48
155	White Dent	White Dent.	A. W. Massey, Mandan, N. D	Poor	Milk to dough	1 to 3	5½	28
156	Selected Rea	White Flint.	A. W. Massey, Mandan, N. D	Poor	Dough	2 to 3	5	20
157	Yellow Dent	Yellow Dent	Fred Meier, Sleepy Eye, Minn.	Fair	Milk to dough	1 to 2	6½	38

* No stand. Crop a failure.

Those varieties which were nearest maturity at frost, "hard" or "mostly hard," were French's Squaw No. 32, Yellow and White Fodder No. 122, Gehu No. 123, Northwestern Dent No. 124, North Dakota No. 148 and Early Ripe Fodder No. 152. All of the above varieties except Northwestern Dent No. 124 are quite dwarf with ears close to the ground.

The varieties which were next in order in maturing, viz: "dough to hard," in which many ears were ripe enough for seed, were selected Northwestern Dent No. 26, Selected Red Acme No. 41, North Dakota No. 100, Golden Dent No. 119 and Will's Dakota No. 126. Will's Dakota has a dwarf stalk with low ears, the other varieties make a good growth of fodder with ears well upon the stalks.

It will be observed that such varieties of corn as Mercer, Triumph, Longfellow and King Philip did not mature sufficiently to produce seed last season. During the average season these varieties ripen sufficiently to produce good corn, while the varieties named above in the second class usually mature fully.

DIFFERENT DATES OF PLANTING CORN.

This experiment, begun first in 1901 and reported in Bulletin No. 51, page 83, was continued in 1902. Two plots of corn were planted each week beginning with May 30th and ending with July 1st. The grain drill was used as a planter and was set to sow two and one-half bushels of oats per acre. One plot was planted in drills six inches apart, another in drills forty-two inches apart, at each separate date. The first plot received no cultivation except harrowing, the second was cultivated throughout the season. The ground used was spring plowed wheat stubble. The soil was cultivated with a harrow or acme pulverizer before each planting. North Dakota No. 100 was the seed corn used in this trial.

The fodder was all cut September 17th, five days after frost and hauled directly to the silo. The product of each plot was weighed and a sample of the fodder was saved and dried and from the percentage lost in drying, the yield of air dry fodder was determined.

The results are given in Table XXIII.

TABLE XXIII.—DIFFERENT DATES OF PLANTING CORN CROP OF 1902.

Plot No.	Date of Planting	Stand	Height of Stalks—feet	Stage of Maturity at Frost	Quality of the Fodder	Yield per Acre		
						Green Fodder—pounds	Air Dry Fodder-pounds	Water in Green Fodder—per ct.
	SIX-INCH DRILLS							
1	May 30..........	Very good.	3	About mature.	Fair.......	12,358	5,057	64.3
2	June 9..........	Very good.	3½	Ready to cut..	Good	11,509	3,838	70.8
3	June 17..........	Thick	5	Ready to cut..	Very good.	15,896	4,861	73.2
4	June 23..........	Fair.......	5½	Immature.....	Good	10,377	2,546	78.5
5	July 1..........	Thick	5	Immature.....	Good	14,434	4,069	75.3
	FORTY-TWO-INCH DRILLS							
1	May 30..........	Very good.	5	Milk to dough	Good	10,375	4,001	66.2
2	June 9..........	Good	5½	Milk to dough	Good	8,794	2,468	72.4
3	June 17..........	Good	6	Silk to milk ..	Good	8,992	2,105	79.5
4	June 23..........	Fair.......	5½	Silk to milk ..	Fair.......	5,138	1,149	80.4
5	July 1..........	Very good.	6	Silk	Fair.......	9,289	2,671	74.8

The air dry fodder was computed as containing fourteen and one tenth per cent of moisture, and the yields are exactly comparable with each other in regard to the actual amount of dry matter produced on each plot.

The corn planted in six-inch drills gave the largest yield for each date of planting. The average for all trials last season by the two methods of planting were as follows:

Average yield of dry fodder, 6 in. drills.. 2 tons, 74 lbs.
Average yield of dry fodder, 42 in. drills.. 1 ton, 479 lbs.

In the 1901 trial the average yields were three tons, 1954 pounds and two tons, 1334 pounds respectively.

The largest yield of air dry fodder in the crop of 1902 was in each case produced by the corn planted May 30th, but the latest planted fodder made a remarkable growth and a comparatively large yield. It would appear that the corn planted July 1st was really more mature at frost than the corn planted June 23rd, not only because of the larger yield of the former but also because the green fodder of the late planted corn contained less water than the other. With this exception the percentage of water in the green fodder increased gradually with the date of planting. Comparing corn planted in six-inch drills and cultivated corn, the green fodder of the latter in every case but one contained the largest percentage of water. The fodder was not cut until five days after frost and had dried out some. In the 1901 trial the green fodder contained on the average about ten per cent more water, but the percentage of moist-

ure varied with about the same relation between the crops from the several plots as is shown in the above table.

PLANTING CORN IN DRILLS VS. PLANTING IT IN HILLS.

This is a repetition of the experiment published in Bulletin No. 51, page 77. The drilled corn was planted with the grain drill which was set to sow two and one-half bushels of oats per acre. It dropped the kernels six to ten inches apart in the drill row. The corn planted in hills was in rows only one way and the rows were three feet and eight inches apart. The hills were eighteen to twenty-four inches apart in the row, with two or three stalks per hill. The corn was planted with an ordinary horse corn planter.

The corn planted in six and twelve inch drills received no cultivation except with the harrow, the other plots were cultivated and kept free from weeds.

The corn was harvested September 17th and hauled immediately to the silo. The yields of air dry fodder were determined as already described for different dates of planting corn.

The results of this trial together with the average yields for two and five trials is given in Table XXIV.

TABLE XXIV.—PLANTING CORN IN DRILLS VS. PLANTING CORN IN HILLS.

Plot No.	How Planted	Height of Stalks—feet	Air Dry Fodder yield per acre, 1902—pounds	Average Yield for two crops, 1901–1902—pounds	Air Dry Fodder yield per acre, average for five crops, 1898-99, 1900, 1901, 1902—pounds	Corn in Ear yield per acre, average yield for three crops, 1898-99, 1900—bushels*
1	Drills 6 inches apart	3½	4,364	6,267	7,370	....
2	Drills 12 inches apart	4	4,431	6,116	6,841	....
3	Drills 18 inches apart	4½	3,449	5,031	6,828	23.1
4	Drills 24 inches apart	5	4,107	5,217	6,721	29.0
5	Drills 30 inches apart	5¼	3,343	4,658	6,427	34.4
6	Drills 36 inches apart	5½	4,057	5,213	6,238	33.7
7	Drills 42 inches apart	5½	3,565	4,846	5,568	32.7
8	Hills, rows 44 inches apart	5¾	3,030	4,562	.....	....
9	Hills, rows 22 inches apart	5¼	4,395	6,302	.....	....

*70 pounds per bushel.

In 1902, corn planted in twelve inch drills gave the largest yield of fodder, while planting in hills and rows twenty-two inches apart gave the next largest yield. Six inch drills stand third in yield. The average for two trials places six inch drills first, rows twenty-two inches apart second, and twelve inch drills third in the total weight of the crop produced.

The average for five trials does not include the corn planted in hills. Comparing the yields from the drilled plots shows a gradual

decrease in yield as the distance between the drill rows increases. The yield of ears has not been taken for the last two seasons. The average for three trials prior to 1901, favor planting in drills thirty, thirty-six or forty-two inches apart when the object is the production of ears.

THICKNESS OF PLANTING CORN IN DRILL ROWS.

In this experiment the corn was planted by hand in drill rows three feet and eight inches apart. The land was wheat stubble, spring plowed. The corn was planted May 31st. North Dakota No. 100 was the variety planted. The crop was cultivated as described under varieties of corn. The fodder was cut September 17th and shocked in the field, where it was allowed to cure until November 3rd, when it was hauled and weighed and the corn was husked. The fodder was not well cured and samples were saved and dried. These samples lost from 36 to 54 per cent in weight. The yields given in Table XXV were determined by calculation, using 12.35 per cent as the percentage of water in the air dry fodder in each case.

Table XXV gives the results of the trial and the average yields for three trials, 1898, 1899 and 1902.

TABLE XXV.—THICKNESS OF PLANTING CORN IN DRILL ROWS.

Plot No.	How Planted	Height of Stalk—feet	Length of Ears—inches	Yield per Acre, 1902		Average for three trials	
				Air Dry Fodder-pounds	Ears-bushels	Air Dry Fodder-pounds	Ears-bushels
1	3⅔ feet by 6 inches	5½	6	7,772	22	7,744	33.4
2	3⅔ feet by 10 inches	5½	6½	6,635	25	5,947	31.3
3	3⅔ feet by 12 inches	5½	6½	7,143	16	6,202	27.6
4	3⅔ feet by 14 inches	5½	6½	6,849	16	5,794	24.4
5	3⅔ feet by 16 inches	5½	7	6,113	15	5,199	22.8
6	3⅔ feet by 18 inches	5½	7	5,902	14	4,647	21.3
7	3⅔ feet by 24 inches	5½	7	4,793	12	3,794	16 8
8	3⅔ feet by 30 inches	5½	7	4,264	9	.....	....
9	3⅔ feet by 36 inches	5	7	3,677	..	3,114	....

Planting one kernel every six inches in the drill row has given the largest yield of fodder in the 1902 trial and also the largest average yield for the three trials.

It will be seen that the corn planted in drill rows three and one-half to three and two-thirds feet apart gave the largest average yield of grain per acre which leaves little doubt that six inches between stalks is the best thickness for planting corn in the drill row.

NUMBER OF STALKS IN A HILL.

In this experiment the corn was planted by hand in rows three feet and eight inches apart and in hills three feet apart in the row. The soil, cultivation, etc., was similar to that noted for thickness of planting in drill rows. The corn was cut September 17th, and shocked in the field. It was hauled November 3rd, upon which date it was weighed and the yield determined as stated above.

Table XXVI gives the results of the trial with the average yield for three trials, 1898, 1899 and 1902.

TABLE XXVI.—NUMBER OF STALKS IN A HILL.

Plot No.	Number of Stalks in a Hill	Height of Stalks—feet	Length of Ears—inches	Yield per Acre 1902		Average for Three Trials	
				Air Dry Fodder—pounds	Ears—bushels	Air Dry Fodder—pounds	Ears—Bushels
1	One	5	7	3,677	7	3,308	12.6
2	Two	5¼	7	3,712	12	3,894	21.4
3	Three	5½	7	4,297	14	4,585	25.3
4	Four	5½	6½	5,390	16	5,405	26.6
5	Five	5½	6½	6,378	19	5,641	27.7
6	Six	5½	5½	6,075	22	6,027	30.4

Five stalks in a hill gave the largest yield of fodder in 1902. Six stalks in a hill has given the largest average yield of fodder for three trials.

It will be seen by Table XXVI that the six-stalk hills gave the largest yield of grain this year, and that they have made the highest average yield during the three years of the trial.

CULTIVATION EXPERIMENTS WITH CORN.

The plan of this experiment was the same as that reported in Bulletin No. 51, page 89. The corn was planted on fall plowed wheat stubble on May 30th, with the Hay's Junior drill planter as already described under varieties of corn. The plots were harrowed once before the corn came up and once afterward. Each plot was cultivated five times. Plot 1 was cultivated shallow each time—not more than two inches deep—with the Deere surface (blades) cultivator. Plot 2 was cultivated about four inches deep each time with the Sunshine six-shovel cultivator. Plot 3 was cultivated shallow the first four times and deep the last time, while plot 4 was cultivated deep the first four times and shallow the last time. The dates of the several cultivations were the same as noted under the varieties of corn.

The corn was cut September 17th, shocked in the field. It was hauled and weighed November 3rd to 7th, and the yields of air dry fodder and ears were determined as already described for different thicknesses of planting in the drill row.

Table XXVII gives the results of the trial and includes the average yields for three trials, 1898, 1899, 1902.

TABLE XXVII.—CULTIVATION EXPERIMENTS WITH CORN.

Plot No.	Method of Culture	Height of Stalks—feet	Stage of Maturity at Frost, Sept. 12	Yield per Acre		Average Yield for Three Trials	
				Fodder—lbs.	Ears—bus.	Fodder—lbs.	Ears—bus.
1	Shallow	5½	Mostly dough, some hard	3,175	......	4,752	....
2	Deep	5½	Dough—some milk, some hard	2,505	......	4,030	....
3	Shallow, early; deep, late	5½	Dough to hard, some about ripe	2,703	......	4,245	....
4	Deep, early; shallow, late	5	Milk to dough, a few hard ears	3,382	......	4,426	....

The corn cultivated deep, early and shallow the last time, gave the largest yield of fodder in 1902. The corn cultivated shallow throughout the season gave the second largest yield. As an average for three trials corn cultivated shallow has given the largest yield of fodder. Unfortunately the yield of grain in the above trial could not be accurately determined with the equipment which the Station has at this time. Had the corn grown upon plots one, two, and four been nearly as ripe as that upon plot three the grain could have been saved. The deep cultivation—probably by reason of the root pruning effect upon the advanced corn—caused that plot to ripen earlier than the other three were able to do.

SOIL MOISTURE STUDY.

The soil moisture study was continued in 1901 along the same lines as were reported in Bulletin No. 48. The percentage of moisture was determined in the soil of several plots which grew different crops or received different methods of cultivation. Samples were taken during the summer of 1901 and also late in the fall. Owing to the abundant rainfall of the season and the wet fall, the moisture in the soil of all plots was found to be much the same and near the point of saturation. The results of the study do not show sufficient difference in the moisture content of the several plots to warrant the publication of the data. It was observed, however, that the

methods of farming, such as rotating with corn, which saved soil moisture in the dry season of 1900, as reported in Bulletin No. 48, do not leave the soil more thoroughly wet in a season of great precipitation than does the ordinary grain farming. In a wet season it appears that the facilities for drainage are better in the corn field, etc., than in the wheat stubble or other grain lands. Thus in the spring of 1902 more moisture was found in the soil of an unplowed wheat field than in the soil of a corn field or even in cultivated summer fallow, while fall plowed wheat land contained fully as much water in the first six feet of soil as was found in either the corn land or the summer fallow.

The season of 1902 proved so wet that the soil moisture study was largely discontinued. A few samples of soil taken at intervals during the season showed the ground to be supplied with moisture, almost to saturation during the greater part of the season.

A WINTER STUDY OF MOISTURE IN THE SOIL.

This experiment was continued during the winter of 1901-2, being the fifth season in which the study has been made. The plan of this experiment has been to take samples of soil for moisture determination from different plots at intervals of one month during the time in which the earth is frozen. The results of former trials are published in Bulletin No. 48, page 77.

The results of last winter's work are given in Table XXVIII.

TABLE XXVIII.—SHOWING PERCENTAGE OF MOISTURE IN THE SOIL AND THE GAIN OR LOSS DURING THE WINTER OF 1901–1902.

Description of Soil	Depth of sample—feet	Date of Taking Samples: Moisture—per cent—Nov. 13, 1901	Moisture—per cent—Jan. 13, 1902	Moisture—per cent—Feb. 24, 1902	Moisture—per cent—March 24, 1902	Moisture—per cent—gain or loss during winter	Total gain or loss of water during winter—in.
Plot. No. 1—Wheat stubble, fall plowed..........	First foot...	38.23	64.20	49.29	48.04	11.06	1.06
	First 3 feet..	32.16	44.33	38.81	39.71	6.65	2.68
	Second 3 feet	33.89	32.36	30.81	30.23	-3.08	-1.60
	First 6 feet..	33.03	38.35	34.81	34.97	1.78	1.03
Depth of water table	....	26 in...	....	....	55½ in.	29½ in.	.....
	Feet—	Per cent	Per cent	Per cent	Per cent	Per cent	
Plot No. 7—Wheat stubble, fall plowed, harrowed after plowing.....	First foot...	44.32	44.30	41.43	43.09	-2.79	-0.27
	First 3 feet..	37.50	38.95	36.58	36.09	-0.92	-0.37
	Second 3 feet	34.10	32.05	31.63	31.38	-2.47	-1.28
	First 6 feet..	35.80	35.45	34.11	35.22	-1.69	-1.56
Depth of water table	....	28½ in.	....	....	50 in...	21½ in.	.....
	Feet—	Per cent	Per cent	Per cent	Per cent	Per cent	
Plot No. 25—Wheat Stubble not plowed............	First foot ...	42.29	47.41	64.40	72.07	22.11	2.12
	First 3 feet..	35.16	37.91	45.93	54.91	10.77	4.34
	Second 3 feet	30.37	31.67	32.86	42.56	2.49	1.29
	First 6 feet..	32.77	34.79	39.40	48.73	6.63	6.12
Depth of water table	....	31 in...	....	....	3 in....	-28 in..	
Brome Grass sod seeded in 1899-hay field	Feet—	Per cent	Per cent	Per cent	Per cent	Per cent	
	First foot...	39.84	38.69	40.40	76.87	0.56	0.05
	First 3 feet..	33.98	31.24	31.63	62.83	-2.35	-0.95
	Second 3 feet	31.87	31.42	31.00	51.32	-0.87	-0.45
	First 6 feet..	32.98	31.33	31.32	57.08	-1.66	-1.53
Depth of water table	....	59½ in.	....	....	....	....	

* The difference is that between the moisture percentages Nov. 13th and Feb. 24th.

The "gain or loss" of moisture during the winter was the difference observed in the moisture content of the soil between November 13th and February 24th. Part of the ground was flooded March 24th, which made it necessary to use the results of the earlier date.

The data shows that plot 1, fall plowed wheat stubble, gained 2.68 inches of water in the first three feet of soil, but lost 1.6 inches in the second three feet during the three winter months.

Plot 7, fall plowed wheat stubble, harrowed immediately after plowing, lost water in every foot of soil. It will be observed, however, that the soil of this plot contained considerable more water than the soil of plot 1, on November 13th.

Plot 25, wheat stubble not plowed gained water in every foot, the total gain in the six feet of soil amounting to 6.12 inches of water.

The Brome grass sod, on the other hand, lost water, except in the first foot, the total loss being 1.53 inches from the six feet of soil.

The results of former trials have been similar to this one in that there has usually been a gain of water in the first three feet of soil during the winter, and a loss in the second three feet. There has usually been a total gain over loss of moisture during the winter months, and the study justifies the conclusion that there is no absolute drying of the soil after it freezes in the fall until it thaws in the spring, and that there may be an actual gain of water in the soil which cannot be accounted for from the rain or snow fall.

THE EDGELEY SUB-STATION REPORT.

The work at the Edgeley Sub-station during the past season was carried on in a manner similar to that reported upon for 1901. The Station arranged with Mr. Jas. M. Plott who owns the adjoining farm to do the work and to keep a greater portion of the records.

Brome Grass. The acre plot of brome grass seeded in 1901 made a rapid growth and reached the heading stage May 26th. It was in blossom July 1st, and would have been in good condition for hay a few days later. It was cut for seed on July 23d. The yield of seed from this one acre plot was 400 pounds. It reached a height of five feet four inches and in every way gave evidence of unusual thrift. A small strip of spring plowed land was sown broadcast with brome grass seed on May 7th at the rate of sixteen pounds per acre without a nurse crop and made a spendid stand, reaching a height of seven inches during the season.

Slender Wheat Grass. The trial of slender wheat grass (agroprum tenerum) at the Edgeley Sub-station was unfortunately interfered with and gave no indication of its probable degree of success in the district.

Timothy. Timothy sown May 7th on spring plowed land at the rate of 12 pounds per acre made a good stand, some of it reaching a height of five or six inches. The mower was run over it on July 29th to cut back infesting weeds.

Turkestan Alfalfa. A plot of ground sown to Turkestan Alfalfa in the spring of 1901 made a thin stand and was badly smothered by a growth of Russian thistle. The stand was so poor that it was not cut at all. An adjoining piece of land was sown to Turkestan alfalfa on May 12th, 1902, and made a good stand, reaching a height of four inches during the season. The weeds were cut off on July 7th which constituted the only attention the plot received after the seed was sown.

German Millet. A half acre plot of spring plowed land was seeded with German millet No. 1073. The seed was sown on May 20th at the rate of two pecks per acre. It made a good growth yielding hay at the rate of two tons per acre.

Japanese or Barn Yard Millet. A half acre plot was sown to Japanese millet No. 647 on May 20th at the rate of two pecks per acre. It did not seem thrifty and did not head out. It made a yield of 1½ tons of hay per acre.

Corn. An acre of North Dakota 100 corn was planted upon a piece of land one-half of which had been plowed four inches deep and the other half at a depth of seven inches. It was planted on May 20th in hills 3½ feet apart. It was harrowed on May 31, and cultivated on June 9th, 16th, and on July 2nd and 12th. All weeds were removed by hoeing July 10th. The corn was soft at frost and Mr. Plott estimated the yield to be 40 bushels of ears per acre or twenty bushels on the basis of ordinary dry corn.

Corn Planted Thick in Rows. Corn planted thick in drill rows was put in May 12th. The crop was harrowed on May 19th and 31st, and on June 9th. It was cultivated and hoed on July 5th and again on July 10th. The corn was killed by frost when quite green, but Mr. Plott's estimated yield of fodder was 1½ tons per acre.

Wheat. The rotation effect of the previous years cropping at Edgeley emphasizes the need of an expert at the sub-station during the entire growing season to note any new or irregular feature which may be present that would not be noticed by an amateur observer. The following results for 1902 were recorded by Mr. Plott:

Plot 4 (in flax in 1901) produced 20 bushels of Minnesota 169 wheat per acre. The grain made a thick stand and was five feet high.

Plot 5 (in wheat in 1901) made a yield of 15 bushels of Minnesota 163 wheat per acre.

Plot 7 (fallowed in 1901) made a yield of 14 bushels of Minnesota 163 wheat. Mr. Plott states that during a dry spell this wheat "burned" in spots.

Plot 6 (in corn in 1901) gave a return of 12 bu. of Minnesota 163 wheat per acre.

Macaroni Wheat. Plot 14 (in barn yard millet in 1901) threshed out 14 bu. of Kubanka wheat. Mr. Plott states that the grain on this plot averaged five feet high and was a good stand but that it was injured by drouth. Plot 18 (in corn in 1901) produced 16 bushels of Velvet Don wheat per acre.

I believe that an alert investigator with soil sampling apparatus and time enough to devote to the study of the plots in question would have found some additional and important facts relative to the trial in question.

Flax. Flax was grown upon plot 4, where a crop of flax was produced last year, and made a yield of seven bushels per acre. The flax sown on the east half of plot 7 and upon plot 8 was badly injured by flax wilt and produced little seed. The trial indicates that good crops can be grown upon land which has produced flax and thereby corroborates the results obtained at the central station.

Oats. White Russian oats was sown upon a third acre plot on May 7th at the rate of two bushels per acre. It was planted upon spring plowed land which had been reduced to a fairly good condition by harrowing. It made a heavy stand of grain and was ready to harvest August 12th. The yield of oats was at the rate of 39 bushels per acre, and the grain was of good weight.

Barley. A third acre plot of six-rowed barley seeded May 7th at the rate of two bushels per acre was hurt by drouth. The plot yielded at the rate of 30 bushels per acre and the grain was of good weight.

Emmer or Spelt. Emmer or spelt was sown on May 7th upon land prepared in a manner similar to that described for oats and barley plots and the plot was one third of an acre in extent. It was badly injured by drouth and yielded 21 1-3* bushels per acre.

Dwarf Essex Rape. One-fourth of an acre of ground was planted to rape in drill rows thirty inches apart on May 12th upon land which had been plowed that day. The rape was cultivated upon the following dates: June 9th, 16th and 26th. It made a good stand and grew from two to three feet high and the leaves covered the entire space between the rows. The rape plant will produce an abundance of forage in the Edgeley district and deserves a place upon every farm in that portion of the state.

A Golden Willow Hedge. A hedge of the Russian Golden Willow 20 rods long was started by putting out cuttings upon spring plowed land. The cuttings were put in on April 30th and made a good growth and a splendid stand, only two or three cuttings in the entire stretch of 20 rods failing to grow.

J. H. SHEPPERD.
A. M. TEN EYCK.

ACKNOWLEDGMENTS.

Mr. E. G. Schollander has aided me in an efficient and loyal manner and has taken much of the responsibility for the field and laboratory work in plant breeding. He has also aided me in the experiment work with the increase plots and in the plant nursery work.

Mr. Schollander has rendered this department valuable service by finding suitable persons to make co-operative trials with improved and new seeds and by pointing out subjects especially needing investigation.

Mr. H. M. Ash has acted as foreman in the department during the year and has become responsible for a great many of the details of the work.

Mr. L. F. Seneco has taken an active part in the expert work in caring for the field plot trials and in curing and preparing exhibition samples of grasses, grains and forage crops.

J. H. SHEPPERD,
PROFESSOR OF AGRICULTURE.

* 48 pounds constitutes the legal weight for spelt in North Dakota.

DEPARTMENT OF HORTICULTURE.

To Director J. H. Worst:

The work in the horticultural department for the season of 1902 was a continuation along the lines already laid out in fruit and vegetable culture and tree growing. To the previous work in vegetable culture was added a test of varieties—largely of sorts furnished by the U. S. Department of Agriculture.

The trials with celery included many of the leading American sorts and some from England that were recommended as superior to our own varieties, particularly in the point of hardiness and keeping qualities. Such claim was found to be unwarranted, as American sorts like the Winter Queen or Giant Pasal are easily superior in growth and quality and equal in all other points to the imported varieties.

The tendency of certain varieties of celery to become pithy was quite marked the past season. This has generally been ascribed to the unfavorable character or condition of the soil. Recent investigations at Maryland Station have shown it to be rather an hereditary weakness due to a continued selection of seed from plants lacking in solidity. It was found that celery grown from French seed which has generally been more carefully selected than American seed, gave a product that was uniformly solid, as compared with a forty per cent pithiness of the same variety when grown from American seed. In view of these results one needs to examine carefully into the character of the seed purchased. The demand for celery in North Dakota still greatly exceeds the supply. The net profit one season with another is about $100 per acre. There is no better variety than White Plume for early nor Winter Queen for late.

The trials with cabbages gave good results, many of the heads without special cultivation and without fertilizer weighing 25 pounds.

The Charlestown Wakefield and Washington Wakefield both develop good heads early, though the Early Summer, coming but little later, is considerably larger. The Harvest Home Upton and Surehead are among the best for the main crop.

The green cabbage worm is getting worse in its depredations year by year and usually needs some attention. Water heated to 170 deg. F. and poured on the plants with a sprinkling can is a very good remedy where but a small number are grown. It should be applied two or three times early in the season and again after the second brood has hatched.

Several sorts of sweet corn were grown, all of them doing well and several producing a product of nearly absolute perfection. Will's Banana Cream, the Sheffield and Early Minnesota are among the best varieties.

Of the tomatoes grown in 1902, which was a very unfavorable season for this fruit, the Early Minnesota and Early Michigan made about the best showing.

Trials were made with practically all of the other garden vegetables chiefly for demonstration purposes. Notes were kept on all of these through the season.

The asparagus rust which first appeared in 1901 attacked the entire bed in 1902 and early in August all of the canes were brown. It will undoubtedly show in a reduced yield the coming year. An attempt was made to try and check its ravages by treating the soil in which isolated plants were growing with ashes, salt, lime, etc. As all of the isolated plants including the untreated ones failed to show the disease, no conclusion was reached. The work is now being continued in the greenhouse and laboratory. The disease is a very serious one and difficult to treat by the ordinary methods of spraying.

SMALL FRUITS.

None of the plums except the De Sota fruited last season. As that was the prevailing condition all over the Northwest, it was attributed to the continued cold rains during the time of blossoming.

The raspberries did not winter well nor bear heavily. The Cardinal made much the best showing in both of these particulars and promises to be a valuable sort. The Colorado Iron Clad also made a fairly good showing.

Of the currants the London Market is the heaviest cropper yet tried and from other reports received it seems to lead most other varieties.

The trial bed of strawberries set in 1901 was partly under water during the spring and many of the varieties were killed entirely. Of the remaining ones the Senator Dunlap wintered the best and made the heaviest yield. Twenty-four plants of this variety set in 1901 produced 24½quarts of berries in 1902. As this variety produces runners very freely one can get a fair sized bed the second year from two or three dozen plants. Its tendency to produce new plants would cause the bed to become matted and worthless unless most of them were removed. The Wm. Belt was also a very productive and showy variety, single berries measuring seven inches in circumference. The Warfield Clyde and Beder Wood produced fairly well.

Where the annual rainfall is not great and the drying effects of sun and wind rather pronounced, as in North Dakota, it is essential to allow plenty of room between the strawberry plants, never letting

the rows become matted and also to give very frequent cultivation. With these precautions a spot somewhat protected by trees may be made to produce this favorite fruit with reasonable certainty.

TREE CULTURE.

About four thousand trees were added to the arboretum during the past season. Most of these were planted as the beginning of an experiment to include planting on several plots using different varieties and different distances of planting. A trip was taken to Pembina County to study the natural forest conditions existing there and to determine the rate of increase in timber growth. The conditions for such study were very favorable and showed in some instances an increase of five cords per acre per year, the timber being white poplar. The price obtained at the place of cutting was $3.00 per cord and the expense of cutting a half dollar per cord. This makes a net profit of $12.50 per acre each year. As the white poplar grows up from suckers after being cut over, there is no expense of replanting. Most of the agricultural lands of the state could doubtless be made to do as well. The acre which was matured and cut gave a yield of ninety cords as a result of eighteen years growth. With the growing scarcity of wood it would seem to be a good investment to plant a part of the farm to trees, inasmuch as the net profit from wheat growing is scarcely a third of $12.50 per acre. If the funds are to be obtained it is the desire of this department to devote considerable time to the cultivation of timber from a commercial basis. It takes time to show results with such a line of experiments, and the work should be begun at once to make the data available as soon as possible. There is a demand for such information now and the station will be missing a great opportunity if it is prevented from supplying what in a few years will be an absolute need. Means should be provided at once for a tree plantation covering at least ten acres.

ENTOMOLOGY.

Several trips were made over the eastern part of the state just before and at the time of harvest to investigate the injury done by the Hessian fly. This insect was found to be pretty uniformly distributed over the eastern portion of the state. In some places the damage was hardly noticeable, but other areas of considerable size, a hundred miles or so across were damaged anywhere from ten to twenty-five per cent. It is probable that the damage for the entire state was not less than 5 or 7 per cent and possibly as high as 8 per cent. The worst damage was found to be in western Cass and Traill counties and in the western part of Walsh county. In 1901 this insect was not very numerous at any point in the state and its abundance in 1902 well shows how quickly it may assume destructive proportions unless properly taken care of. The wet condition existing over the eastern part of the state in 1900 and 1901 prevented the

plowing of stubble land and also prevented the burning of stubble. These large areas contain a considerable number of the Hessian fly in the flax seed stage and they readily made their escape in the spring from the undisturbed stubble lands. If the stubble can be burned either in the fall or very early in the spring, there is no possibility of any danger resulting from this pest, as it has no way to pass the winter except in the wheat stubble. The very great prevalence of the insect in 1902 makes it a most serious menace to wheat farming in the immediate future unless the stubble is universally destroyed by burning or early spring plowing should not be delayed after the first day. The fact that the adult insects can fly, or are at least carried by the wind for miles makes it necessary that not only the stubble of any particular locality be destroyed, but the entire affected region.

Some little damage was done in different parts of the eastern counties during the season by the grasshoppers, but in no instance was the destruction very wide spread. Patches of from forty to one hundred acres were in a few instances pretty well destroyed, but their ravages did not extend beyond that. The parasites of the grasshoppers have become so numerous within the past two seasons that it is doubtful if there will be anything like a serious outbreak during the season of 1903. This department, particularly in its recommendations.

The horticultural work has been considerably hampered because of lack of greenhouse room and also because of the entire absence of rooms and cellars suited for the wintering of the half hardy plants and the carrying over of material needed for the grafting and the general propagation of plants. With a reasonable sum expended in the construction of new greenhouses, the Experiment Station work could be improved upon to a very considerable extent.

C. B. WALDRON,
Horticulturist.

REPORT OF DEPARTMENT OF VETERINARY SCIENCE.

Hon. J. H. Worst, Director:

SIR: Having only recently taken charge of this department, I am not in position to render a full report of the work accomplished by it during the past year. As far as my information goes, the work done here principally consists of teaching the young men composing our classes the nature and management of animal diseases, as far as they pertain to farm animals. The instructions were given by didactic lectures and by clinical demonstration. At the present time the same line of teaching is being followed.

Students taking the long term courses are being drilled in comparative anatomy and physiology in addition to the regular veterinary course. The short winter term students are given short outlines in

anatomy and physiology, so they can profit more by the lectures given on disease proper. In giving the young men instruction in animal diseases, the more common ailments and diseases are taken up and they are not only shown what they themselves can do in the way of treatment, but also what they cannot do.

Especial stress will be laid on the nature, management and prevention of contagious and infectious diseases. This is not only taken up for their individual profit, but as a matter of public interest. Pains will be taken to make it clear, that in the management of communicable diseases we have to deal with problems affecting the welfare and interests of others as well as of ourselves.

Judging by my personal observations, the students take great interest in this course, the classes being large and the average attendance good.

As to Other Lines of Work. This department is frequently consulted by the stock growers of the state as to diseases occurring in their herds and flocks. Information is frequently given, specimens are analyzed and practical suggestions made.

Original research has not been done during the last year, but as soon as the department will be provided with the necessary apparatus some line of work will be taken up. This work will be selected with a view to the needs of the state.

The department is located in four very convenient rooms in Francis Hall, which are fully adequate to its requirements. There is however a lack of instruments, scientific apparatus, teaching models and specimens, while some improvements are needed in connection with our operating room. Some of the teaching appliances have been ordered, however, and when installed will greatly increase the usefulness of this department.

Respectfully submitted,

L. VAN ES,

Professor of Veterinary Science.

STATEMENT.

OF RECEIPTS AND EXPENDITURES FROM JULY 1, 1901, TO JULY 1, 1902.

RECEIPTS.

Received from U. S. Hatch Act, March 2, 1887........ $15,000

DISBURSEMENTS.

By salaries	$7,211.27	
Labor	3,328.01	
Publications	914.40	
Postage and Stationery	65.00	
Heat, Light, Water and Power	577.38	
Chemical Supplies	97.92	
Seeds, Plants and Sundry Supplies	592.08	
Feeding Stuffs	789.83	
Library	19.00	
Tools, Implements and Machinery	490.22	
Scientific Apparatus	417.89	
Live Stock	350.00	
Traveling Expenses	124.00	
Contingent Expenses	23.00	
Total		$15,000

S. E. NUGENT,
Secretary.

FOURTEENTH ANNUAL REPORT

OF THE

North Dakota Agricultural Experiment Station

AGRICULTURAL COLLEGE, NORTH DAKOTA

TO THE

GOVERNOR OF NORTH DAKOTA

BISMARCK, N. D.
TRIBUNE, STATE PRINTERS AND BINDERS
1904

STATION STAFF.

J. H. Worst, LL.D.	Director
E. F. Ladd, B. S.	Chemist
C. B. Waldron, B. S.	Horticulturist
H. L. Bolley, M. S.	Botanist
J. H. Shepperd, M. S. A.	Vice Director and Agriculturist
L. Van Es, M. D. V. S.	Veterinarian
L. R. Waldron, M. A.	Assistant Botanist
T. R. Manns, B. S.	Assistant Botanist
J. C. McDowell, B. Agr.	Assistant Agriculturist
O. A. Thompson, B. S.	Superintendent Edgeley Sub-Station
E. G. Schollander	Assistant in Plant Breeding
Nicholas Grest	Farm Foreman
C. E. Nugent	Secretary

64149

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LETTER OF TRANSMITTAL.

AGRICULTURAL COLLEGE, N. D.,
February 1, 1904.

Hon. Frank White, Governor of the State of North Dakota:

SIR: As required by act of congress approved March 2, 1887, I hereby submit the Fourteenth Annual Report of the North Dakota Experiment Station for the year ending February 1, 1904, together with a financial statement of receipts and disbursements, as required by law, for the government fiscal year ending June 30, 1903.

Very respectfully yours,

ALEX. STERN,
President Board of Trustees.

REPORT.

To the Board of Trustees of the North Dakota Agricultural College and Experiment Station:

GENTLEMEN: I have the honor to submit to you the Fourteenth Annual Report of the North Dakota Government Experiment Station.

The following bulletins were published during the year:

No. 55. Flax and Flax Seed Selection.
No. 56. Noxious Weeds and How to Kill Them.
No. 57. Some Food Products and Food Adulterations.
No. 58. Some Stock Poisoning Plants of North Dakota.

FARMERS' INSTITUTES.

Since the Thirteenth Annual Report was published, farmers' institutes were held at Fingal, Wimbledon, Kensal, Carrington, Cathay, Harvey, Kenmare, Carpio, Milnor, Barney, Wahpeton, Hamilton, Drayton, Grafton, Langdon, Park River, Larimore, Valley City, McHenry and Cooperstown.

INSTITUTE CORPS.

The institute corps consisted of M. F. Greeley conductor, editor of the Dakota Farmer, published at Aberdeen, S. D.; Bertha Dahl Laws, of Appleton, Minn.; A. K. Bush, Dover, Minn.; D. S. DeLancy, Valley City, N. D.; E. G. Schollander, Agricultural College; Thomas Convey, Ridgway, Wis.; L. D. Stilson, York, Neb.; N. S. French, Berlin, N. D.; T. A. Hoverstad, Crookston, Minn., and O. A. Thompson, superintendent Edgeley Sub-Experiment Station. The work of conducting institutes, however, was mainly in charge of Mr. Greeley and Mr. Bush.

As heretofore, the demand for farmers' institutes has far exceeded the ability of the institute board to supply speakers, notwithstanding the material increase of the appropriation by the last legislative assembly for institute work. Many one-day institutes had to be scheduled where two-day institutes would have been more satisfactory, and quite a large number of petitions for institutes were received that could not be entertained for want of funds. The growing demand for farmers' institutes and their economic advantage to the farming community fully warrants the most liberal appropriations for conducting them that is consistent with the financial con-

ditions of the state and the relation which agriculture bears to the other interests of the commonwealth.

IMPROVED BREEDS OF STOCK.

The Experiment Station has made some progress in the improvement of live stock, having recently purchased a young Shorthorn bull of exceptional quality. Also four Shorthorn and four Hereford heifers of the best breeding types have been recently added to the Station herd.

A thoroughbred Rambouillet ram and eleven pure bred ewes of the same breed have been added to the Station flock. A start has also been made in securing pure bred pigs.

It is the policy of the Station to secure as rapidly as possible, pure bred cattle, sheep and hogs of the strains best adapted to local conditions.

Not having any available funds for the purchase of the above mentioned stock, some of the less desirable animals belonging to the Station were disposed of and the pure bred stock partly paid for from the proceeds of such sales. For the balance the Station had to go in debt.

Considerable attention has been given to experiments with poultry raising and egg production during the past year, with encouraging results. The experiments will be more extended during the coming year.

THE STATION DEPARTMENTS.

The reports from the several departments for the past year, found elsewhere in this report, are of unusual interest. Lack of funds for initiating important experiments and for enlarging the scope of investigations now under way proves a serious handicap to the Station staff. Another serious matter is the frequent changes that occur among the assistants in the Department of Agriculture. Other stations and even private parties overbid us in the payment of salaries and take away our help almost as fast as it becomes well trained for special work. The state should provide not less than $15,000 annually as its equitable share for the support of the Experiment Station. The annual investment of that sum would enable the Station to retain efficient men in its service for longer periods, and in general results it would return the appropriation to the state many fold annually. At the present time North Dakota is one of the few states that does not co-operate, at least equally, with the federal government in the work of experimentation.

As will be found in the report of the State Veterinarian, cattle scabies has become seriously prevalent on the western ranges. The Station will continue to devote its best energies to eradicate this evil, and reasonably expects, through co-operation with the state

government and the United States Department of Agriculture, to see the disease completely stamped out. The Department of Veterinary is working to great disadvantage for want of a suitable building for making experiments with diseased stock and for dissecting animals. The Departments of Agriculture and Horticulture are also without buildings suitable for their special lines of work—not even having a place where seeds can be protected from the mice and rats.

An effort will be made to experiment to some extent with grasses and forage crops in the grazing sections of the state the coming year. This important work was projected a year ago, but the Station was prevented from doing anything for want of funds. Where, from overstocking or other causes, the native grasses are disappearing from the ranges, an honest effort should be made to improve the pastures, and experiments also should be made with forage crops with a view to supplementing the native hay for winter feed.

The home Station will continue the line of experiments heretofore inaugurated and initiate additional experiments as occasion demands. The rotation experiments were very gratifying the past year, and will be continued; also experiments looking toward the development of a strain of flax that will be immune from the disease known as flax wilt.

The Sub-Station located at Edgeley, for the past year superintended by O. A. Thompson, under the direction of Vice Director J. H. Shepperd, and assisted by Prof. C. B. Waldron, horticulturist, was gratifying in the results obtained, notwithstanding the money and energies available were largely used for the erection of buildings, for fences, team and farm implements. I respectfully call your attention to the report of the agriculturist for a more detailed account of the results obtained at the Edgeley Sub-Experiment Station. I also invite your special attention to the work of the state pure food commissioner and his recommendations.

J. H. Worst,
Director.

CHEMICAL DEPARTMENT.

To J. H. Worst, Director:

SIR: I present herewith my Fourteenth Annual Report as chemist of the North Dakota Government Agricultural Experiment Station for the year 1903.

Many of the lines of investigational work in progress during the year are not completed, and the data is reserved until more definite results and conclusions can be presented. The principal lines of work for the year have been with soils, food products, waters, fertilizers and their influence on wheat production, and breeding wheats and corns for high proteids.

The amount of correspondence during the past year has increased more than 150 per cent over that of the preceding year. During the year 1,664 letters have been written and about 1,500 postal card notices have been sent out. The copy books show 1,928 pages of letters written by the department. Often the questions asked have required considerable work to find the data necessary to give an intelligent answer, and in some instances special analyses have been undertaken in order to aid the questioned. Our records show that not less than 9,500 determinations and tests have been made during the year just closed.

The department has been very seriously hampered for lack of proper room or facilities for conducting the work of the Station and College. At times we have felt that our work is far from being creditable to the institution. When one examines the conditions under which we have been forced to carry out our work and experiments, one may well wonder how anything could be accomplished. I quote from my last annual report on this point as follows:

"I do not know of another experiment station department of chemistry in this country so poorly housed and provided for doing work as our own, and this, too, in one of the states almost purely agricultural."

In addition to our regular duties there has been placed a new duty upon the department, that of analyzing foods and passing upon the purity of all food products and beverages sold in the state of North Dakota.

LAW REGULATING THE SALE OF COMMERCIAL FERTILIZERS.

In our last annual report we called attention to the need of a law to regulate the sale of commercial fertilizers in the state, and pointed out that, while the amount of fertilizers used is very small at the present time, there was a tendency on the part of certain parties to induce farmers to make an experiment with the use of fertilizers, and that, in some instances, the fertilizers supplied were almost worthless for the purpose for which they were intended.

At the last session of the legislature, a law such as we suggested was enacted, making it the duty of the Experiment Station to inspect the fertilizers, and to see that the same were what they purported to be. We give herewith a copy of the law as it now stands.

SALE AND ANALYSIS OF COMMERCIAL FERTILIZERS.

An Act to Regulate the Sale and the Analysis of Commercial Fertilizers, and Prescribing a Penalty for the Violation Thereof.

Be It Enacted, etc.:

SECTION 1. Every person who shall sell, offer or expose for sale in this state any commercial fertilizer or any material to be used as a fertilizer, the selling price of which exceeds five dollars per ton, shall stamp on or affix to each package of such fertilizer, in a conspicuous place on the outside thereof, a plainly printed statement which shall certify as follows:

1. The number of net pounds of fertilizer in the package sold or offered for sale.
2. The name, brand or trade mark under which the fertilizer is sold.
3. The name and address of the manufacturer of the fertilizer.
4. The chemical composition of the fertilizer expressed in the following form and order:

......per cent phosphoric acid soluble in water.
......per cent phosphoric acid reverted.
......per cent phosphoric acid insoluble.
......per cent phosphoric acid total.
......per cent nitrogen in nitrates.
......per cent nitrogen as ammonia.
......per cent nitrogen total.
......per cent potash soluble in water.
......per cent chlorin.

If any such fertilizer be sold, offered or exposed for sale in bulk, such printed statement shall accompany every lot and parcel so sold, offered or exposed for sale.

SEC. 2. It shall be a violation of the provisions of this act if the statement required by section 1 of this act shall be false in regard

to the number of net pounds of fertilizer in the package sold, offered or exposed for sale, or in the name, brand or trade mark under which the fertilizer is sold, or in the name and address of the manufacturer of the fertilizer. It shall also be a violation of the provisions of this act if any commercial fertilizer or material to be used as a fertilizer shall contain a smaller percentage of nitrogen, phosphoric acid or potash than is certified therein, when such deficiency shall be greater than one-third of one per centum of nitrogen, or one-half of one per centum of available phosphoric acid (or one per centum of the total phosphoric acid in the case of the undissolved bone), or one-half of one per centum of potash soluble in distilled water.

SEC. 3. Before any commercial fertilizer or any material to be used as a fertilizer is sold, offered or exposed for sale in this state, the manufacturer, importer or person who causes the same to be sold, offered or exposed for sale shall file with the North Dakota Government Agricultural Experiment Station a certified copy of the statement prescribed in section 1 of this act, and, in addition, such statement shall be filed thereafter annually during the month of December. Each maufacturer, importer or person, before selling, offering or exposing for sale in this state any brand of commercial fertilizer, shall annually, during the month of December, pay to the director of the North Dakota Government Agricultural Experiment Station a license fee of twenty dollars for each and every brand of fertilizer bearing a distinctive name, brand or trade mark, which said manufacturer, importer or person is to sell, offer or expose for sale in this state during the calendar year next succeeding said payment; provided, always, that the placing of any new brand upon the market at any time during the calendar year shall be preceded by such payment. Each manufacturer, importer or person who has complied with the provisions of this act relative to filing the aforesaid certified statement and to the payment of the aforesaid license fee shall be entitled to receive a certificate from the director of the said station setting forth said facts. Said director shall pay all money received as aforesaid to the treasurer of the North Dakota Government Agricultural Experiment Station, which treasurer, when said money is so appropriated by the board of trustees of said station, shall pay the money so received, or so much of it as may be necessary in maintaining the expenses of enforcing the provisions of this act. Said board of trustees shall report annually the expenditures so incurred for salaries, laboratory expenses, chemical supplies, traveling expenses and printing.

SEC. 4. No person shall sell, offer or expose for sale in this state leather, or its products of other inert nitrogenous material in any form, as a fertilizer or as an ingredient of any fertilizer, unless an explicit printed statement of the fact shall be conspicuously affixed to every package of such fertilizer, and shall accompany every parcel or lot of the same.

SEC. 5. Every person violating any of the provisions of this act shall forfeit and pay to the people of the state of North Dakota the sum of one hundred dollars for every such violation.

SEC. 6. Every certificate, duly signed and acknowledged by the chemist of the North Dakota Government Agricultural Experiment Station at Fargo, relating to the analysis of any commercial fertilizer, shall be presumptive evidence of the facts therein stated.

SEC. 7. The doing of anything prohibited by this act shall be evidence of the violation of the provisions of this act relating to the things so prohibited, and the omission to do anything directed to be done shall be evidence of a violation of the provisions of this act relative to the things so directed to be done.

SEC. 8. The director of the North Dakota Government Agricultural Experiment Station is charged with the enforcement of the provisions of this act, and for this purpose may employ agents, chemists and experts, and whenever he shall know or have reason to believe that any penalty has been incurred by any person for the violation of any of the provisions of this act, or that any sum has been forfeited by reason of any such violation, he shall report the said violation with a statement of the facts to the state's attorney for the district wherein the offense is committed, who shall begin proceedings according to the state law.

SEC. 9. This act shall take effect when approved.

Approved March 19, 1903.

SUMMARIES OF TEMPERATURES, RAINFALLS AND SUNSHINES.

Below are given the summaries by months of the daily meteorological observations made during the year. In the preceding annual reports are given the data for former years beginning with 1892:

TEMPERATURE AND RAINFALL—1903.

Month	Mean	Maximum	Minimum	Rainfall—Inches
January	7.0	46	—30	.83
February	2.5	40	—38	.45
March	22.1	50	— 5	.42
April	42.7	76	14	1.34
May	55.7	89	23	2.78
June	62.3	97	33	.56
July	65.8	95	37	2.62
August	62.2	92	37	4.61
September	52.0	83	22	5.61
October	45.2	72	11	2.49
November	23.6	73	—15	.10
December	11.8	37	—25	1.00
Average and totals	37.7	70.9	5.4	23.81

The rainfall for 1903 has been 2.93 inches above the average for the past twelve years. While the rainfall for the year has been above the average, yet for the first six months the rainfall was exceptionally low for the month of June, being but .56 inches. The unusual distribution of rain resulted in retarding much the growth of all cultivated crops, but the rain for July, although far below the average for the month, produced a good yield of grain, especially of wheat.

The rainfall since 1892 is given in the following record:

	1892	1893	1894	1895	1896	1897
Rainfall—inches	20.73	16.17	18.72	16.05	21.77	22.50

	1898	1899	1900	1901	1902	1903
Rainfall—inches	16.36	21.20	25.54	25.68	23.16	23.81

This gives an average annual rainfall of 20.88 inches for the past twelve years, with a minimum of 16.05 inches in 1895 and a maximum of 25.68 inches for 1901.

The rainfall by months for the past nine years is shown in the following table:

RAINFALL BY MONTHS.

Month	1895	1896	1897	1898	1899	1900	1901	1902	1903
January	.36	1.90	.35	.06	.29	.45	.05	.18	.83
February	.12	.06	.77	.10	.29	.54	.11	.34	.45
March	0	.48	.96	.34	1.58	1.23	1.31	1.42	.42
April	1.36	3.64	.89	.88	1.39	1.82	1.76	2.30	1.34
May	1.62	4.70	.74	4 15	4.22	.81	.98	4.25	2.78
June	4.81	2.41	7.10	2.25	3.44	2.11	5.91	3.07	.56
July	3.24	.91	8.24	2.59	2.78	3.91	7.29	2.54	2.62
August	1.59	2.17	.77	2.84	3.71	8.28	1.59	2.95	4.61
September	1.55	2.58	.57	1.23	1.24	3.27	2.57	.58	5.61
October	.14	1.96	1.81	1.62	1.67	2.80	3.83	5.17	2.49
November	1.16	.70	.25	.08	.27	.20	0	.19	.10
December	.10	.26	.04	.22	.33	.12	.28	.17	1.00
Summary	16.05	21.77	22.50	16.36	21.21	25.54	25.68	23.16	23.81

MONTHLY RECORD OF SUNSHINE.

A Friez photographic sunshine recorder is employed for preserving the record of sunshine by months. No correction is made for early morning and evening sunshine, which is about 12 or 15 per cent greater than the indicated sunshine as shown upon the record.

SUNSHINE RECORDED—1903.

Month	Total Hours		Hours Daily Mean		Percentage Possible Sunshine
	Possible	Recorded	Possible	Recorded	
January	278.9	80.9	8.99	2.60	29.83
February	287.1	172.9	10.2	6.17	60.19
March	369.0	117.4	11.9	3.78	29.76
April	407.3	185.5	13.5	6.18	46.20
May	466.3	239.8	15.04	7.73	51.29
June	475.0	267.5	15.8	8.9	56.36
July	480.2	223.5	15.4	7.2	46.32
August	.....	.....	.....	.....	.....
September	378.3	137.1	12.61	4.57	37.47
October	337.6	153.2	10.5	4.9	46.23
November	281.6	81.4	9.38	2.7	29.3
December	272.1	54.7	8.7	1.7	20.1
Total or mean	4,013.4	1,013.9	12.00	5.22	41.18

In the accompanying table is shown the percentage of actual recorded sunshine by months for the past five years.

PER CENT OF SUNSHINE BY MONTHS.

Month.	1899	1900	1901	1902	1903
January	31.3	37.8	40.0	44.4	29.83
February	51.9	50.0	50.2	46.0	60.19
March	55.5	44.9	48.9	36.7	29.76
April	61.6	65.8	42.7	51.3	46.20
May	39.1	68.2	64.8	48.6	51.29
June	52.2	55.1	40.4	49.6	56.36
July	63.7	56.1	53.5	60.5	46.32
August	42.8	36.4	57.9	46.9	.....
September	58.7	38.9	55.8	51.4	37.47
October	29.4	31.2	57.7	43.0	46.23
November	39.3	36.6	42.8	29.3	29.3
December	47.7	30.2	22.3	32.1	20.1
Mean	48.8	47.1	49.43	45.2	41.18

The total hours of recorded sunshine and the percentage of possible sunshine for the past five years is summarized in the following table:

	1899	1900	1901	1902	1903
Total hours recorded ...	2,166.85	2,116.5	2,203.7	2,034.8	1,813.9*
Daily mean hrs. recorded	5.97	5.70	6.05	5.61	5.22
Percentage of sunshine.	48.8	47.1	49.43	45.2	41.18

* The record for 1903 is deficient for the entire month of August. The instrument was tampered with and the record destroyed.

The percentage of sunshine has regularly decreased from 48.8 per cent to 41.18 per cent from 1899 to 1904. The records show a higher rainfall for the same period.

EVAPORATION FROM A WATER SURFACE.

This experiment was conducted in the same manner as for the preceding year and given in the Thirteenth Annual Report, page 20.

The table shows the amount of water evaporating daily, expressed in inches:

Date	May	June	July	August	September
1	.05	.0	.39	.07	.20
2	.20	.10	.06	.05	.55
3	.06	.20	.23	.24	.05
4	.04	.30	.30	.62	.04
5	.16	.40	.36	.50	.20
6	.20	.20	.55	.50	.0
7	.19	.39	.60	.70	.0
8	.07	.21	.50	.15	.0
9	.12	.18	.50	.40	.0
10	.20	.20	.49	.0	.20
11	.10	.20	.28	.40	.0
12	.10	.40	.40	.10	.0
13	.30	.20	.50	.20	.0
14	.10	.42	.60	.30	.06
15	.20	.42	.23	.30	.0
16	.30	.50	.39	.50	.20
17	.20	.40	.25	.60	.10
18	.02	.30	.60	.13	.20
19	.33	.16	.30	.65	.20
20	.20	.13	.43	.50	...
21	.0	.40	.40	.48	...
22	.05	.20	.60	.65	.30
23	.30	.30	.60	.0	.10
24	.20	.20	.50	.0	.30
25	.0	.50	.10	.0	.33
26	.20	.30	.80	.0	.10
27	.10	.40	.20	.03	...
28	.10	.25	.70	.0	.20
29	.20	.42	.50	.0	.22
30	.0	.41	.30	.10	...
31	.0	...	.60	.30	...
Total mean	4.30	8.69	13.26	12.07	3.55
Daily mean	.138	.289	.427	.387	.137

The total amount of water evaporated from a water surface for the five months May to September, inclusive, was 41.87 inches, or an average of 8.37 inches per month, or a daily average of .263 inches.

The summary by months is given in the following table, also that for 1902:

INCHES EVAPORATION FOR 1902 AND 1903.

	1902	1903
May	6.48	4.30
June	5.75	8.69
July	4.77	13.26
August	6.62	12.07
September	4.50	3.55
Total	28.12	41.87

The amount of evaporation for the months May to August, inclusive, for the season of 1903 was 38.34 inches, as compared with 23.62 inches for the same period of 1902. The rainfall for the same period was 10.57 inches for 1903 and 13.71 inches for 1902.

The results of our tests for evaporation for the two growing seasons are interesting, and, taken in connection with the uncompleted results from soil surfaces, furnish some interesting and instructive data. This experiment will be continued through several seasons.

The rainfall for the same period of term was by months as follows:

INCHES OF RAINFALL.

	1902	1903
May	4.25	2.78
June	3.97	.56
July	2.54	2.62
August	2.95	4.61
September	.61	5.61
Total	14.32	16.18

EXPERIMENTS WITH COMMERCIAL FERTILIZERS.

At the request of the Amour Fertilizer Works, South Omaha, Neb., in the spring of 1903 we undertook some experiments to determine to what extent the use of commercial fertilizers would increase the yield of wheat. The experiments were made on the station grounds, and samples of the fertilizers were furnished to farmers in different parts of the state, with the request that they apply the same at the rate of 200 pounds per acre to their wheat fields, carefully note the results and make a general report at the time the crops were harvested. The fertilizers were furished to the following parties:

J. A. Power, Power, N. D.

Sub-Experiment Station, Edgeley, N. D.

J. A. Davis, Buxton, N. D.

Dugald Campbell, Armstrong, N. D.

Col. W. W. McIlvain, Enderlin, N. D.

Experiment Station, Agricultural College, Fargo.

To each of these was sent a quantity of the following fertilizers: Acidulated Bone Meal, Amour's Grain Grower, Ammoniated Bone with Potash, All Soluble. These fertilizers were furnished by the

Amour Fertilizer Works for this experiment. We also sent a quantity of sodium nitrate, furnished by the Chilian Nitrate Works, through the courtesy of its director, William S. Myers.

When the crop was harvested and threshed in the fall, the farmers reported that they were unable to see that there was any advantage in favor of the use of the fertilizers; that possibly the wheat where the nitrate of soda was used was more stalky and continued its growth somewhat later than was the case with the other grains.

EXPERIMENTS AT THE STATION.

At the Experiment Station, where the facilities were such that the work could be done more satisfactorily, and accurate records could be made and weights made of the harvested crop and the actual data secured for yield of wheat per acre, we have a means of determining to what extent the several fertilizers influenced the yield of wheat.

The guaranteed analysis for the several fertilizers furnished by the Amour Fertilizer Works is shown in the following table:

	Acidulated Bone Meal	Amour's Grain Grower	Ammoniated Bone and Potash	All Soluble
Nitrogen	1.64 to 2.47	1.65 to 2 47	2.47 to 3.29	2.88 to 3.7
Ammonia	2 to 3	2 to 3	3 to 4	3.5 to 4.5
Total phosphoric acid	18 to 22	10 to 12	8 to 10	10 to 12
Available phosphoric acid	11 to 14	8 to 10	6 to 8	8 to 10
Water soluble phosphoric acid	8 to 12	....	4 to 6	2 to 4
Potash, muriate	....	3.17 to 4.75	....	....
Potash, sulphate	....	....	3.70 to 5.50	7.40 to 9.25
Potash, K_2O	....	2 to 3	2 to 3	4 to 5
Equal bone phosphate	39 to 48	....	....	....

In addition to the above, on plot No. 104 an application of nitrate of soda was made, and on plot 105 ten loads of well rotted manure were applied, while plot 106 received no fertilizer.

The ground on which this experiment was made had grown wheat or other grain crops continuously for more than twenty years and without the addition of fertilizers of any kind, so that the conditions were favorable for the experiment, at least so far as concerns lands in the Red River valley which have been continuously in wheat farming since the prairie was first broken.

The experiments were directly in charge of Mr. E. G. Schollander, who makes the following statements regarding the results:

FERTILIZER EXPERIMENT RESULTS—1903.

Analysis No.	Name of Fertilizer	Length of Stem	Length of Heads	Yield Per Acre—Bushels	Weight Per Bu.—Pounds	Per Cent Lodged
100	Acidulated Bone	37 in.	3¼ in.	30.40	59.75	10
101	Amour's Grain Grower	37 in.	3½ in.	33.20	59.50	5
102	Ammoniated Bone	37 in.	3 in.	32.20	61.25	20
103	All Soluble-	36½ in.	3½ in.	31.90	60.00	8
104	Nitrate of soda	37½ in.	3¼ in.	33.00	59.50	10
105	Rotted manure	35½ in.	3¼ in.	29.50	60.00	10
106	No fertilizer	34 in.	3 in.	25.70	60.00	3

NOTE.—The first part of the season there was no noticeable difference on any of the plots, but the latter part of the season it was readily seen that No. 106 did not stand as thick on the ground nor heads as well filled as the other plots.

Two hundred pounds per acre of the different fertilizers were used on Nos. 101, 102, 103 and 104. Ten loads of well rotted manure per acre were used on No. 105, and no fertilizer of any kind on No. 106. This was used as a check plot.

E. G. SCHOLLANDER.

The results shown in the table indicate the largest yield on the ground where Amour Grain Grower Fertilizer was used. Here the yield was at the rate of 33.2 bushels as against 25.7 where no fertilizers were added. This shows an increase of 7.5 bushels per acre as the result of adding 200 pounds of the fertilizer. The yield where nitrate of soda was added was only .2 of a bushel less than that in favor of the Amour Grain Grower Fertilizer.

It will be noticed also that the addition of rotted manure at the rate of ten loads per acre made an increase of 3.8 bushels per acre.

It is proposed to continue this line of experiments and determine to what extent the use of fertilizers will add to the yield of the wheat crop, both at the Experiment Station and at the Sub-Station at Edgeley.

In order to determine to what extent the fertilizer might influence the amount of ash or mineral constituents of the wheat and the proteid content, determination was made in each case with results as given below:

Plot	Name of Fertilizer	Ash	Proteid Nx6.25
100	Acidulated Bone	1.91	12.97
101	Amour's Grain Grower	1.82	14.18
102	Ammoniated Bone	1.90	12.22
103	All Soluble	1.92	13.68
104	Nitrate of soda	1.81	14.12
105	Rotted manure	2.07	12.63
106	No fertilizer	1.95	13.06

From the analysis it will be noticed that the fertilizers which gave the largest yield per acre also produced a wheat containing the highest proteid content and the smallest per cent of ash.

SOIL STUDIES.

One phase of soil investigation was assigned to Hugh McGuigan for study, and while the work is only fairly under way, it is believed that some points have been established and are pointed out in his preliminary paper, which I include with this report. An effort has been made to determine differences in humus from different sources, and from the same soil under different conditions of cultivation and farming.

It has been found that when fractional precipitation is employed with humus extracts very different results are had with varying conditions of soils. In some cases all of the humus is precipitated in the first fractional, and in other cases all may come down in the last fractional, and in other cases about the same amount will be had for each precipitation. It has been found, however, that these several precipitates have very different values and widely varying compositions. This problem is now being further investigated, and it is believed results can be had which will throw much light upon some of the problems not well understood.

Another point too much overlooked, especially in newspaper discussions of humus questions, is the fact that there are many kinds of humus, as there are many kinds of food products. Roughly it may be said that there are nitrogenous humuses and carbonaceous humuses with all the gradations, just as foods may be classed as nitrogenous and carbonaceous foods. These have different values in the soil as widely varying as the foods themselves. Humus from green clover and clover roots is very different from humus produced from, say, wheat straw and wheat roots.

How do each of these classes of humus affect the mineral plant food constituents of the soil? How do they influence the physical condition of the soil? These and many other related questions can be answered with advantage to practical agriculture.

HUMUS AND ITS RELATION TO AVAILABLE PLANT FOOD.

BY HUGH M'GUIGAN.

With the cultivation of cereals, mankind shows an advancement from the barbarous to the civilized state. As soon as knowledge of the importance of the cereals as a food has disseminated amongst a people, the conditions necessary for their easier and more profitable production begin to be studied. For this reason we find that the regions where grain could be raised easiest and most abundantly were the most prosperous and populous. It was by reason of their agricultural advantages that the valleys of the Nile, Tigris and Euphrates were former seats of power and progress. In time, however, the inherent power to produce crops which a region possesses will, by reason of continual cropping, be shorn of its power, unless the conditions necessary for its preservation are understood and a proper course pursued. Because of the violation of nature's laws, regions which were formerly the centers of prosperity are now barren wastes with scarcely anything to indicate their former fertility The exhaustion of the soil became visible at an early date, and in many cases was treated successfully though empirically. With the development of chemistry, and especially agricultural chemistry, the reason for each treatment has been questioned, and, in many cases, definite answers given. These answers, however, were not obtained without a controversy ranging over a period of some fifty years, and still there are unsettled questions.

EARLY VIEW OF HUMUS AND ITS USES.

The most fertile fields everywhere are noticeable for the amount of vegetable mould or humus they contain. The value of humus as a plant food has been much discussed and today remains a vulnerable question. Many beautiful theories relating to value, composition and production were raised only to be rendered untenable by the definite decision of experiment. Previous to the time of Liebig (1803-1873) the wonderful powers of virgin soils and the decrease of these powers by continued cropping had so impressed agriculturists that it was almost universally believed that their productiveness was entirely due to the larger amounts of vegetable moulds which these soils contained. Many vegetable physiologists held that it was the chief nutriment of plants. Although their theories seemed plausible, yet they were not entirely satisfactory, and investigation of the matter was continued. The first to study the sub-

ject with any measure of scientific satisfaction was Justus Von Leibig. He observed that humus is of very variable composition; it is soluble in water only when freshly precipitated; it becomes almost entirely insoluble after drying or freezing, so that both the heat of summer or cold of winter render it insoluble, at least so far that it, or its constituents, is of very little worth as an assimilable plant food. Before a substance can be utilized by plants, it must be soluble; hence at first sight it was seen that humus as it is found in the soil cannot be used as a plant food. Physiologists did not deny this, but to overcome the difficulty they assumed that the alkalies, lime, etc., found in the ashes of plants render the humus soluble, hence assimilable. As one part of the lime will combine with almost eleven parts of humic acid, the hypothesis seemed possible. To test the validity of the hypothesis Liebig made numerous calculations, and showed a doubt that the available humus on a given area is far too small to account for the vegetable raised there, even after granting numerous impossibilities in favor of the theory. "He showed that the proportion of carbon produced on an acre of cultivated land from such various crops as fir wood, pine wood, beech wood, beet root, rye and hay is remarkably constant under dissimilar conditions of cultivation. Also that carbon may be removed to some extent from a forest or meadow, in the form of wood or hay, and that in spite of this the soil will become richer, not poorer, in carbon. And finally he clinched the argument by pointing out that since it is universally admitted that humus is only produced by the decay of plants, no primitive humus could have existed for the first plants, for plants must have preceded humus." Such was the disposal of the humus theory, and must be forever discarded by reasonable men.

Carbonaceous vegetable matter while oxidizing does improve the physical condition of the soil and act beneficially in other ways, but it is not entirely necessary, as plants grow in earth in which it is entirely absent. This, however, does not diminish its practical importance in the soil, nor should it encourage negligence in its preservation.

Priestly, before Liebig's time (1771), had proven that plants in sunlight absorb carbon dioxide from the air and give off oxygen, and in England at least, some inclination to regard the air as the source of the carbonaceous material was shown, until Ingenhouz discovered that, although the above process takes place in daylight, yet the reverse is true in darkness. It was this latter discovery that gave strength to the humus theory and preserved it until the time of Leibig (1840).

We know now that the discovery of Ingenhouz is more of a quantitative character. Although the discovery misled many botanists and plant physiologists, yet it was found to be far from sufficient to counterbalance the carbon dioxide taken up during the day. Humphry Davy showed plainly the production of oxygen from carbon dioxide

by plants by growing grass under receivers in water with an air supplied with small additional quantities of carbon dioxide gas. After a lapse of eight days the air in the receiver was found to be decidedly enriched with oxygen, proving, at least, that plants take part of their carbon dioxide from the air.

LATER VIEWS ABOUT HUMUS.

Having, to a certain degree, determined the source of the carbon dioxide for plants, the next question, and the question still unanswered, is to determine the composition and work of humus in the soil. When it was believed that plants derived their carbonaceous matter from the soil, physiologists believed that humus must be particularly nutrient, because in composition it differed from wood chiefly in containing an excess of carbon. "Like wood, it contained carbon, together with hydrogen and oxygen, in the proportions which they combine to form water, but relatively to the proportion of carbon the proportion of water is less. Misled by this fact the physiologists concluded that this similarity of composition between humus and the constituents of plants must favor the assimilating of the former plants. Humus had only to unite with water to form woody fibre."

This reasoning from analogy proved very erroneous, for no vital characters of the plant justify the assumption that the vital processes of plants and animals are similar.

Plant life consists of the elaboration of sugar, gums, starches and the like, substances entirely necessary for animal life; and humus, which is apparently an analogous substance, could hardly be considered as a plant food. While it is not a direct plant food, it is almost as important in the soil as though it were. It is true that a great many soils can produce a crop without a great deal of it, yet in regions which are subject to long periods of drouth, as in the Dakotas, it is the only reliable insurance against crop failure. Just how much study can be given it with propriety can be seen by every one interested in the preservation of soil fertility.

SOME FUNCTIONS OF HUMUS.

While we do not know the entire role played by it, yet we can give some of the beneficial effects of its presence. The first of these is the physical condition. Soil containing an abundance of vegetable matter is much easier tilled than those deficient in it. They also preserve a more uniform temperature, hold more hygroscopic moisture, and crops growing on such do not suffer the destructive effects of hot winds or drouth as those growing on a soil poorer in humus. This is especially noticeable between crops growing in the Red River valley and those on the higher and humus deficient soils outside of it. Both are subject to the same climatic conditions. This ability to withstand drouth and hot winds is largely due to the much greater

water holding capacity of the soils richer in humus. The following figures give the amounts of humus found in different soils and the water holding capacity of each, volatile matter, etc., due to its presence. The samples were taken from plots marked 2 and A. Both of these have been under continuous cultivation for twenty years. On 2 there has been wheat continuously, while A has grown grain, wheat, oats and barley for a similar period. Results from the first and second six inches are given:

TABLE I.—HUMATES, HUMUS AND WATER HOLDING CAPACITY OF SOIL.

Sample Soil	Humates	Humus	Water Holding Capacity—Per Cent
Virgin sod, first six inches	6.80	4.78	82
Virgin sod, second six inches	9.54	3.54	68
Plot 2, first six inches	9.40	5.06	68
Plot 2, second six inches	8.16	3.45	64
Plot A, first six inches	13.10	4.75	76
Plot A, second six inches	10.00	3.70	64

Two years later we made a comparison of a dozen rotation plots of the same kind of soil, to see the effects of rotation on the amounts of humus, water capacity, etc., and found that with a proper rotation the virgin strength and productiveness may be reserved if not increased. It is needless to give a table of the complete results, a comparison of 2 and 18, which show the greatest difference, will be sufficient. Number 2 has had wheat continuously for twenty-three years. Number 18 has been under cultivation for a similar period, but the wheat was rotated only since 1892, as follows:

1892, peas.
1894, clover.
1895, fallow.
1899, peas.
1903, clover.

With soils taken from the first ten inches we obtained the following results:

Sample Soil	Humates	Humus	Water Holding Capacity
Plot 2	15.17	6.15	70.00
Plot 18	11.57	6.12	82.00

It has been shown by several writers that prolonged cultivation without addition of fertilizers reduces the amount of humus, or at least depreciates its value in the soil. However, this reduction does

not take place so rapidly as might be imagined. Virgin soils in many cases, contain a less amount of humus than those that have been cropped for several years. This is particularly true of soils that have been properly handled. In fact, in all our work on the Red River valley soils we invariably find more humus in those that have been cultivated for from five to ten years. The above table verifies this statement. On the other hand, while the virgin soil contains less humus, it invariably has a greater water holding capacity, a larger per cent of organic matter and more hygroscopic moisture. The organic matter, when the soil is cultivated, may increase the amount of humus. It is in these characteristics that the power lies to produce a crop in a dry season, when the long cultivated soil practically fails. During the year 1900, virgin soils and rotated soils produced an abundant yield of wheat, while soils such as 2 and A were failures; yet both these soils are extremely rich in plant food. They contain as much or more humus, but their physical characters are changed and they are "wheat sick." Just what these changes embrace, and what their relation is to the available plant food, is a matter yet to be determined.

The following table gives the total volatile matter in air dried samples, and also the moisture given off on drying at 100 degrees Centigrade.

TABLE II.

Sample Soil	Total Volatile Matter	Per Cent Given Off at 100 Deg.
Virgin soil, first six inches	26.20	8.90
Virgin soil, second six inches	15.96	5.30
Plot 2, first six inches	21.35	6.27
Plot 2, second six inches	8.75	6.16
Plot A, first six inches	18.65	4.98
Plot A, second six inches	16.45	4.98
Plot 2, first ten inches	18.97	4.73
Plot 18, first ten inches	23.46	4.08

As stated above, virgin soils with ordinary cultivation, at least those in the Red River valley, for a few years increase slightly in the amount of humus they contain. Those rotated properly, and especially those upon which some leguminous crop occasionally grows, will considerably increase the amount of humus and also the water holding capacity. However, with ordinary cultivation, it is generally conceded that there is a decrease in the amount. This decrease will be noticeable in the different regions at different times from the beginning of cultivation, depending upon the original humic contents of the soil. It could not be expected that soils as rich as those of the Red River valley would show a decrease as early as those of a region that originally contained but half their wealth and crop producing power. Yet with all their apparent richness, and with a great per cent of humus, soils 2 and A were practical failures in the year 1900, while virgin soil and those properly rotated yielded

fair crops. This leads us to believe that virgin humus and humus from long cultivated soils are not entirely the same, and do not hold the same relation to the mineral nutrients of the soil. Roberts says: "When the humus is taken out of native soils during the process of analysis, from .06 to .08 per cent of the phosphoric acid is soluble and associated with it, while only about .02 per cent is in this with the long cultivated soils. In some parts of the country this estimate is undoubtedly correct, but in the Red River valley, where the soil contains more of the plant food than is found in any other country, we find the estimate very low. In plot 2, in an amount of extract corresponding to two grams of soil, we found the merest trace of phosphoric acid, while some well cultivated ran as high as .12 per cent, or about 50 per cent of the total phosphoric acid in the soil. Bulletin 24: "There is a good supply of phosphates in all of these soils, but we must keep up the supply of humus to keep the phosphates available, etc. It will thus be seen that the great value of humus resides not only in its increasing the moisture holding capacity of the land, but in its power of liberating phosphoric acid."

While the functions of all the mineral nutrients of the plants are important and necessary to growth and fruitage, potassium, phosphorus and nitrogen may be ranked as first, not because plants require these any more than they do a certain amount of iron, calcium or magnesium, but because they are drawn upon most largely in proportion to the amount of them that is found in the soil, and they are most liable to be exhausted. Cooke says that "potash is to the plant what milk is to the child." Considering it in this light we can gain an idea of its importance. If, for any reason, the plant is deprived of a sufficient supply of potassium, it cannot be expected to assimilate the phosphorus, calcium, etc., in later life necessary for the formation of the seed or brain.

Phosphorus is especially necessary for the formation of lecithin and the nucleo-proteids. Both of these are found in the protoplasm of cereals, and, to a considerable extent, determine their value as a food. It is taken up in the form of phosphates, and is always found in relation with living protoplasm. Though the significance of this fact is unknown, its presence is considered essential to the complete development of the plant by cell division. Many soils, and especially Red River valley soils, contain enough phosphoric acid for generations to come, if properly cared for. The question is how to keep a suitable amount in available form. As it exists in the soil, it is partly in a soluble or available form, and partly in an insoluble or unavailable form. The first only is directly assimilable, and hence of use to plants. Again, after we have a sufficient supply of available acid, by poorer methods of cultivation and the absence of organic matter and lime, it may again be reverted to the unavailable form. It is found in the soil mostly in combination with the bases lime, magnesium, iron and alumina, and for the most part insoluble in water. All, with the exception of aluminum compounds, are ren-

dered soluble by the action of the carbonic acid water found in the soil. Knowing, then, that we have a good supply of phosphorus in the soil, the aim should be to retain as much of it in an available form as is necessary for the growing crop, without endangering a needless waste.

POTASH IN THE SOIL AND IN HUMUS.

The amount of potash in combination with humus is very much greater than the amount of phosphoric acid. The amount in numbers 2 and 18 was:

Plot No. 2	0.30 per cent
Plot No. 18 ...., ...	0.50 per cent

Nitrogen, the third member of the "essential three," is required by all green plants and especially by those rich in protein substances. But for the complete, healthy and normal development of the plant, potassium and phosphorus must be in conjunction with it. Nitrogen is believed to be taken up mainly in the form of nitrates; and as all nitrates are very soluble and easily washed away, the value of humus in the soil is readily seen. As shown in the table above, the water holding capacity of a solid depends, in a great measure, upon the humus, though it may vary slightly with the form of the humus.

That the nitrogen is held in a different combination in well cultivated and in poorly cultivated soils cannot be doubted. Though the amount of humus in number 2 and number 18 may in itself show nothing, the element it contains shows that it is much deteriorated in number 2. In fact it may be compared with wheat of different grades. There may be just as much of the poor one, but its value is much less. In a potassium extract, we found in humus, in terms of soil, of number 2 contained 0.14 per cent nitrogen, while number 18 contained 0.32 per cent. The difference in the two is more than many arable soils contain.

The portion of the rainfall in excess of the amount necessary to saturate a soil, not lost by evaporation, must percolate into the subsoil and hence carry a portion of the nitrates down with it. If, however, there is an amount of humus sufficient to hold the rainfall, within the first foot or so of the soil, this waste by leaching is prevented, and at the same time all the soluble nitrogen held within reach of the plant. A determination of the quantity of nitrates in the soil shows this to be a fact. (Bull. p. 47.) The same is true of potash and phosphoric acid. The following table gives the amount of these substances in the soils under consideration:

TABLE III.

Sample Soil	Per Cent Phosphor. Acid P_2O_5	Per Cent Potash K_2O	Per Cent Nitrogen N
Virgin sod, first six inches	0.35	0.58	0.51
Virgin sod, second six inches	0.28	0.49	0.30
Pot 2, first six inches	0.30	0.51	0.42
Plot 2, second six inches	0.30	0.46	0.28
Plot A, first six inches	0.29	0.52	0.42
Plot A, second six inches	0.22	0.50	0.25

Considering the fact that twenty-two crops have been removed from 2 and A, and that these soils, at least in unfavorable climatic conditions, give very inferior returns, we would naturally infer that some plant food was wanting.

An examination of the above table shows that there is still a great abundance of the three elements mentioned. There has not been so much of them removed as we might have anticipated; but what amount of them is available in the virgin and cultivated states we have not yet determined. That there is an abundance of all other elements can be seen in Table IV, which gives a fuller analysis.

TABLE IV.

	Virgin Soil		Plot II		Plot A	
	1st 6 in.	2d 6 in.	1st 6 in.	2d 6 in.	1st 6 in.	2d 6 in.
Silica, $Si\ O_2$	62.01	70.05	65.18	67.65	67.80	69.52
Lime, Ca O	0.98	0.77	0.74	0.88	0.99	0.65
Magnesia, Mg O	0.11	0.07	0.08	0.06	0.16	0.11
Aluminum, $Al_2\ O_3$	5.53	7.26	6.59	7.26	10.16	12.37
Iron, $Fe_2\ O_3$	3.40	4.12	3.66	4.03		
Phosphoric acid, $P_2\ O_5$	0.35	0.28	0.30	0.30	0.29	0.22
Sulphurous acid, $S\ O_3$	0.09	0.12	0.09	0.09	0.10	0.12
Potash, K_2 O	0.58	0.49	0.51	0.46	0.52	0.50
Soda, Na_2 O	0.59	0.28	0.58	0.28	0.21	0.20
Volatile matter and carbon dioxide	26.20	15.90	21.35	18.75	18.65	16.45
Total	99.84	99.40	99.08	99.76	98.88	100.14

There is an abundance of plant food in all these "wheat sick" soils as is clearly demonstrated by growing corn, potato or leguminous crops on them without the addition of a fertilizer. Afterwards, for several years, they will continue to produce remarkably good crops of wheat. In fact, experiments at this Station have shown that if we are to grow four crops of wheat after a number of years continuous wheat, we can get a great number of bushels if instead of four wheat crops we plant one leguminous crop and follow by three of wheat. Just what change takes place in the humus under these conditions is not known. However, we do know that in vir-

gin and in properly rotated soils there is a very much greater amount of phosphoric acid, potash and nitrogen in combination with humus than in the long cultivated ones.

Another point we must remember: For a good crop in this region nature requires a larger stock of reserve material than in regions where the rainfall is twice as large. To hold this reserve material in proper relation to the available material, a certain amount of humus is necessary.

After washing the soil with dilute acid and extracting the humus with a 40 per cent solution of ammonia, we have the humus extract. From this extract we can precipitate a number of humate compounds with hydrochloric acid. By neutralizing or acidifying we get the total precipitate, but at all points before reaching the acid condition we get a precipitate. In some of the work we add just enough of the acid to neutralize one-half of the ammonia solution and filtered off precipitate, and find that, just as heat and cold change the quality of humus, so solvents will likewise change it. If we allow an extract of it to stand for any length of time, a fine silty deposit gathers on the bottom of the vessel. This amount will be different for the various soils. After standing for several months the addition of the acid will give a much larger precipitate than when the extract is freshly prepared. For instance, after this length of time, on adding enough acid to half neutralize the solution we obtained the following results:

Plot	Humates Per Cent	Humus Per Cent
No. 2	11.78	3.27
No. 18	4.87	1.55
Freshly prepared—		
No. 2	2.54	1.43
No. 18	4.23 (?)	1.99 (?)

From all observations we find that number 18 is much more stable in character than number 2.

WATER HOLDING CAPACITY OF HUMUS.

The fresh humate precipitate has a remarkable water holding capacity. This capacity differs in the alkaline (in this work the precipitate obtained by half neutralization) and acid precipitates. From seven widely different determinations we get the following results:

WATER HOLDING CAPACITY.

Alkaline humus	1,100 per cent
Acid humus	940 per cent

From the amount of humates in the soil, these figures necessitate the holding of a larger amount of water when separated from, than when in combination with, the soil.

The alkaline precipitates also contain in most cases a greater amount of elements in combination. Following are the results:

TABLE V.

	Alkaline Humus	Acid Humus
Iron, Fe_2O_3	6.40	1.60
Alumina, Al_2O_3	0.76	0.72
Potash, K_2O	0.76	0.50
Acid phosphorus, P_2O_5	1.38	1.46

In the case of phosphoric acid the result is to be doubted. Observations lead us to believe that the alkaline precipitates contain the greater amount. From work now in process, we hope to gain a better knowledge of humus, its changes, combinations and relations to the available plant food and maintenance of soil fertility.

WHEAT BRAN AND SHORTS.

From the Milnor Milling Company was received a quantity of bran and shorts produced from Aronatka or Macaroni wheat. These feed products were analyzed and the results are given in the following table:

	Aronatka or Macaroni Bran	Shorts
Water	10.90	10.35
Ash	5.25	4.14
Fat	5.92	5.90
Crude fibre	10.80	6.05
Proteids	12.25	14.37
Nitrogen free extract	54.88	59.19
Total	100.00	100.00

The question was asked: "How do these products compare in food value with the products from spring wheat?" For comparison we give the analysis of spring wheat bran and shorts as follows:

	Wheat Bran	Shorts
Water	11.50	11.80
Ash	5.40	4.60
Fat	4.50	4.50
Crude fibre	8.00	7.40
Proteids	16.10	14.90
Nitrogen free extract	54.50	56.80
Total	100.00	100.00

From the above it will be seen that the bran from spring wheat is richer in proteids than that from the Macaroni, while the shorts have about the same amount of proteid.

A peculiar feature is the fact that, while wheat bran usually contains about 2 per cent more of proteid than the shorts, in this case the bran has 2 per cent less of proteid than the shorts, or nearly 4 per cent less of proteid than the average for spring wheat brans. The Aronatka bran contains 1½ per cent more fat than the average for ordinary spring wheat bran. Other samples of these mill products will be examined and a further study made of the flour products from Macaroni wheat.

STOCK FOOD.

A sample of International Stock Food was sent in by Hon. A. H. Laughlin, Lisbon, N. D., and found to have the following composition:

	Per Cent
Water	5.93
Ash	17.51
Fat	5.18
Crude fibre	9.36
Proteids, Nx6.25	14.81
Nitrogen free extract	47.21
Total	100.00

This sample was found to contain 6 per cent of sodium chloride (salt), and to contain considerable charcoal, pepper (presumably cayenne), and a bitter principle resembling gentian.

The basis of this product seemed to be a waste product from some flour mill, and its composition showed it to correspond very closely with bran.

The stock foods are usually sold at fabulous prices when we consider the food value contained in them. If we are to consider them in the light of medicines, the question may be fairly asked whether it would not be found more economical to purchase charcoal, salt, cayenne pepper, gentian, fenugreek, etc., to be fed animals where such products are needed. The entire food products cost from eight to twenty-five cents per pound, or from $160 to $500 per ton, when purchased in this form. The same amount of food material could have been purchased in the form of wheat bran or linseed meal at from $15 to $22 per ton. Certainly pretty expensive for the usual medicinal constituents contained in one ton of these foods.

Like the bitters sold for human consumption, these foods are claimed to be a panacea for all the ills of animals.

Such claims do not seem to be based on facts, judged from the experiments which have been made with them by careful investigators.

Well animals do not need medicine, and to stimulate the activity of one set of organs by means of drugs will usually result in functional derangement.

The cost of nutrients in these foods is excessive. Animals, if sick, should be treated for a specific purpose and by one competent to judge of their ailment.

PRAIRIE GRASSES.

Four samples of native grasses, gathered on the ranges in the western part of the state, have been analyzed for water free substance; also a sample of flax shrive from one of the flax mills.

	Ash	Fat	Crude Fibre	Proteids	Nitrogen Free Extract
Buffalo grass	10.30	3.74	23.20	5.81	56.95
Blue gama grass	.....	2.96	27.85	8.44	.....
Quack grass	9.41	4.50	25.93	16.12	44.04
Sand grass	5.13	2.13	33.46	9.06	50.22
Flax shive	4.37	3.46	47.47	5.62	39.08

EXCELSIOR FEED.

Two samples of Excelsior feed have been examined. This feed is produced by the Great Western Cereal Co., Chicago. The feed laid down in Fargo, sacked, cost $16.80 per ton.

Sample No. 1 was taken from the agent's selling sample.

Sample No. 2 represents the composition of the Excelsior feed furnished by the company. The analysis was for the water free substance, but the actual water content was found to be 7.42 per cent.

ANALYSIS OF EXCELSIOR FEED.

	No. 1	No. 2
Ash	3.78	4.24
Fat	5.82	4.83
Proteids	11.25	9.75
Crude fibre	10.45	15.48
Nitrogen free extract	68.70	65.70
Total	100.00	100.00

There is quite a marked difference in composition between the agent's selling sample and that shipped by the company, the agent's sample containing 1 per cent more fat, 1½ per cent more proteids or nitrogenous matter, and 5 per cent less of crude fibre than the food furnished.

The feed did not prove palatable to the cows, and only when mixed with other grain feed could they be induced to eat it.

THE STRENGTH OF COMMERCIAL FORMALDEHYDE.

During the past year there was considerable complaint that the formaldehyde that was being sold in various parts of the state was not always of the required strength. Several samples were sent in

from different parts of the state for analysis, and in some cases it was found that, as claimed, the chemical was much below the strength which it should have.

Below we give the results of a few analyses:

ANALYSES OF FORMALDEHYDE.

Sample from—	Formaldehyde—per cent
Noyes Brothers & Cutler, St. Paul	36.92
S. E. Garry, Knox	26.27 (bulk)
C. R. Merideth, Casselton	36.37
R. F. Mackall, Moorehead	27.72 (bulk)
J. S. Whitcomb, Casselton	31.98
Dr. Geo. Leininger, Chicago	37.75
J. S. Whitcomb, Casselton	28.90 (bulk)
Noyes Brothers & Cutler, St. Paul	34.76
C. R. Merideth, Casselton	36.25
Noyes Brothers & Cutler, St. Paul	38.21
Klipstein & Co.	35.78
Noyes Brothers & Cutler, St. Paul	34.20
Chas. W. Plains, Milton	42.37
Leithhead Drug Co.	40.40
Noyes Brothers & Cutler, St. Paul	40.17
H. E. Close, Milton	38.93
Geo. Draper, Osnabrook	40.56
Noyes Brothers & Cutler, St. Paul	40.17
R. H. Watson, Willow City	39.50

From the above analyses it will be seen that there is coming into the market formaldehyde, usually in carboys, and, so far as reported, all emanating from a single Chicago house, which falls far below the standard strength of 40 per cent. This is a matter of great importance, for farmers who use a formaldehyde containing from 26 to 27 per cent in place of 40 per cent solution for killing wheat smut will most certainly find the process a failure. To what extent this low grade formaldehyde occurs in the state I do not know, but farmers have complained that the treating of wheat, to destroy smut, had in their hands proved a failure. Is it not likely that the fault, in part at least, may be due to using a product such as I have mentioned?

SELECTING WHEATS FOR HIGH PROTEIDS AND GLUTEN.

In 1900, in co-operation with Professor Shepperd of the Department of Agriculture, we began the selection of wheats from individual heads to determine what could be done in the way of increasing the per cent of proteids, or whether wheats with high proteids would continue to propagate this fixed property from year to year. At first a large number of samples were selected, but gradually these have been reduced in number as the results indicated that the tested samples did not continue to propagate with uniformly high proteid content.

At the present time but eight samples are under experiment, and these have been grown for four years with results as shown in the following table:

Sample No.	Plant No.	Crop 1900		Crop 1901		Crop 1902		Crop 1903	
		Ni.	Pro.	Ni.	Pro.	Ni.	Pro.	Ni.	Pro.
107	65C	2.09	13.16	3.6[illegible]	22.74	2.83	17.68	2.75	17.19
108	58B	2.97	18.56	3.37	21.06	3.03	18.94	2.48	15.50
113	36A	2.42	15.13	3.78	23 62	2.76	17.25	2.58	16.13
114	36B	2.42	15.13	4.24	26.50	2.82	17.65	2.62	16.38
112	15C	2.54	15.88	3.55	22.19	3 12	19.50	2.53	15.81
111	68A	2.75	17.18	3.25	20.3[illegible]	2.93	18.31	2.57	16.06
109	55A	2.56	16.00	3.10	19.37	2.78	17.37	2.67	16.69
110	55D	2.45	15.31	3.19	19.93	3.34	20.87	2.52	15.75

It will be observed from the preceding table that the several wheats have not all continued to increase in proteid content, in fact, in some cases the crop for 1903 shows a lower nitrogen content than that for 1900. We should not, however, interpret the results too closely, since the character of the season has much to do in determining the proteid content of wheat. In 1901, the season being unfavorable to full maturity, the proteid content ran exceptionally high for all of the samples. It is proposed to continue this experiment for a few years from the selected seed. Each season from the seed of the preceding year the grain is being grown in quantity, so that of each selection we now have enough wheat for a further study to determine the gluten content and the character of the constituents constituting the gluten. The result of these tests will be given with a forthcoming report, and will form the basis for selecting the seed most promising for growth in larger quantity.

CORN FODDER.

Corns were grown in 1903, planted at different thickness, and the resulting crop analyzed. The following description applies to the method of growing:

No. 146. Corn grown in drills forty-four inches apart, and in hills from two to three feet in the drills.

No. 144. Corn grown in drills thirty inches apart, and in drills six inches.

No. 140. Corn sown in drills six inches apart.

The following table shows the analytical result for crops of 1903 in comparison with that of 1901:

	No. 146		No. 144		No. 140	
	1901	1903	1901	1903	1901	1903
Ash	5.87	6.80	5.82	6.93	5.93	7.83
Fat	2.89	2.52	4.32	2.95	3.49	2.95
Crude fibre	27.39	24.54	26.16	22.80	27.82	26.72
Proteids	8.31	6.81	8.50	7.18	8.75	5.25
Nitrogenous free extract	55.54	59.33	55.20	60.04	54.01	57.25

The crop of 1903 was badly moulded in curing, the season being unfavorable for harvesting corn.

CORN SELECTED FOR HIGH PROTEIDS.

In 1901, from the corn crop of that season, Mr. Schollander selected by physical examination several lots of corn for high proteids. The analyses of these samples was published in the Thirteenth Annual Report. Below we give the comparative results for the three years. In a few instances the crop of 1902 was not analyzed. In the last column is given the analyses for the crop of 1902, taking two rows the full length of the ears in place of a portion from the mixed and shelled sample of corn.

PER CENT TOTAL PROTEIDS.

Sample No.	Crop 1901	Crop 1902	Crop 1903	Two Rows Per Ear
123	14.00	14.00	12.37	13.13
124	13.13	14.00	13.31	15.06
125	13.44	14.00	13.06	15.75
126	13.88	14.87	14.50	12.25
127	15.44	15.44	12.93	15.44
128	15.31	14.31	14.50	15.06
129	13.69	14.00	12.63	11.06
130	13.31	14.00	15.93	10.69
131	13.56	14.00	15.37	13.81
132	13.13	15.75	13.81	10.69
133	13.13	12.93	13.63	11.88
134	13.56	14.68	12.06	14.00
135	11.69	.....	12.75	12.06
136	13.00	.....	12.63	12.81
137	13.31	.....	15.68	10.50
138	11.56	.....	10.13	11.00
139	14.00	.....	12.94	.....

The last row compared with 1902 shows some marked differences notably in No. 132, but in each case later anaylses confirmed the first

finding. It will be observed that samples No. 130 and 131 show a high proteid content, and the increase has been uniform for each year.

COMPOSITE SAMPLES.

To further test the results, ten ears were selected from each of a few lots to determine what variations would be found in larger quantities grown from the same seed in 1902. The results are given below:

Laboratory Number	Composite Sample Proteids
134	13.31
135	12.62
136	11.56
137	11.93
138	12.43

The work of selecting and breeding for high proteid content is to be continued and extended to field work.

ANALYSIS OF INDIVIDUAL STALKS OF CORN.

In the experiments in selecting corn for high proteid content, the seed to be used in developing corn with fixed proteids of per cent, it seemed well to determine what effect, if any, there might be upon different parts of the plant aside from the kernel. To that end a large number of fairly full analyses have been made of the corn plant, of the cob and of the kernels. These results are presented in the following table, expressed as water free substance:

Laboratory No.	Plant		Ash	Fat	Proteids	Crude Fibre	Nitrogen Free Extract
314	10	Stalk	6.40	2.87	6.81	29.58	54.34
314	10	Cob	2.10	.70	3.68	35.00	58.43
314	10	Kernel	2.19	3.07	14.87	3.16	76.71
315	24	Stalk	7.03	2.10	8.31	28.30	54.26
315	24	Cob	1.56	.31	2.13	35.59	60.41
315	24	Kernel	2.12	3.46	15.75	3.14	75.53
316	3	Stalk	7.67	2.76	7.56	28.88	53.13
316	3	Cob	1.66	.47	3.00	36.62	58.25
316	3	Kernel	2.00	3.46	14.00	2.80	77.74
318	25	Stalk	7.41	2.79	7.18	28.58	54.04
318	25	Cob,	1.72	.46	2.37	39.18	56.27
318	25	Kernel	2.12	3.63	12.93	2.70	78.62
321	7	Stalk	7.68	1.94	8.44	29.38	52.56
321	7	Cob	1.55	.43	1.06	35.53	61.43
321	7	Kernel	2.22	2.98	13.31	3.70	77.79
323	16	Stalk	7.26	2.87	8.00	30.47	51.40
323	16	Cob	1.80	.59	2.43	38.73	56.45
323	16	Kernel	1.93	2.90	14.00	2.56	78.61
328	26	Stalk	7.44	3.34	7.00	27.36	54.86
328	26	Cob	2.24	.83	4.18	32.42	60.33
328	26	Kernel	2.09	3.57	14.68	3.07	76.59
331	17	Stalk	7.97	2.68	9.56	28.80	50.99
331	17	Cob	2.43	.60	4.06	35.13	57.78
331	17	Kernel	2.18	3.15	13.63	3.09	77.95
332	18	Stalk	6.80	2.60	8.37	29.78	52.45
332	18	Cob	1.93	.70	2.25	34.85	60.27

ANALYSIS OF INDIVIDUAL STALKS OF CORN—CONTINUED.

Laboratory No.	Plant		Ash	Fat	Proteids	Crude Fibre	Nitrogen Free Extract
332	18	Kernel	1.99	3.36	14.00	2.85	77.80
337	22	Stalk	6.59	2.58	8.56	30.37	51.90
337	22	Cob	1.56	.56	3.68	39.70	54.50
337	22	Kernel	2.06	3.95	14.00	2.94	77.05
338	11	Stalk	6.35	2.19	10.50	29.89	51.07
338	11	Cob	2.15	.68	4.18	34.66	58.33
338	11	Kernel	2.09	3.18	15.75	3.07	75.91
342	1	Stalk	7.38	2.63	8.69	27.25	54.05
342	1	Cob	....	....	......	......	.....
342	1	Kernel	....	....	......	......	.....
343	9	Stalk	7.05	2.71	9.62	27.81	52.81
343	9	Cob	1.68	.53	3.13	36.21	58.45
343	9	Kernel	2.19	3.74	14.00	2.58	77.49
344	4	Stalk	6.66	2.69	7.68	28.25	54.72
344	4	Cob	1.90	.53	2.12	36.74	58.71
344	4	Kernel	2.14	3.58	14.00	2.85	77.43
345	15	Stalk	6.48	2.97	8.94	29.51	52.10
345	15	Cob	1.60	.48	3.00	34.86	60.06
345	15	Kernel	2.17	3.78	14.31	2.58	77.16
346	6	Stalk	6.93	2.79	9.75	29.05	51.48
346	6	Cob	2.19	.67	3.18	34.73	59.23
346	6	Kernel	2.00	3.71	13.25	2.96	78.08
347	5	Stalk	7.45	2.79	9.93	34.16	45.67
347	5	Cob	1.88	.41	2.25	34.50	60.96
347	5	Kernel	2.08	3.48	14.00	2.88	77.56

CORN PLANTED ON DIFFERENT DATES.

For several years it has been the custom of the Agricultural Department to grow corn planted on different dates, to determine the yield and influence on problems connected with soil fertility. In 1901 and again in 1903 corn grown under these conditions was analyzed, taken from the field crop planted in drills six inches apart, also from drills forty-two inches apart. In the following table the results are given for the water free substance:

Planted	Year	Drill	Ash	Fat	Crude Fibre	Proteids Nx6.25	Nitrogen Free Extract
June 8	1901	6 inch	8.12	3.20	29.12	7.19	42.30
June 8	1903	6 inch	7.45	2.69	24.10	7.00	58.76
June 8	1901	42 inch	7.03	5.30	27.80	8.69	51.18
June 8	1903	42 inch	9.67	2.46	25.40	6.00	56.47
June 15	1901	6 inch	8.84	3.80	28.66	8.19	50.51
June 15	1903	6 inch	9.50	2.77	26.12	3.68	57.93
June 15	1901	42 inch	......	....	......	......	.....
June 15	1903	42 inch	8.61	2.90	27.60	6.13	54.76
June 27	1901	6 inch	8.26	3.73	30.45	9.50	48.06
June 27	1903	6 inch	8.79	1.43	25.87	5.61	58.28
June 27	1901	42 inch	7.40	3.20	28.48	9.19	51.73
June 27	1903	42 inch	8.01	3.01	22.75	6.81	56.42
July 2	1901	6 inch	12.91	2.73	31.24	10.06	43.06
July 2	1903	6 inch	......	....	......	......	.....
July 2	1901	42 inch	11.42	2.77	32.94	10.94	41.97
July 2	1903	42 inch	8.84	3.01	23.46	7.00	57.69

The crop for 1903 was badly cured, the fall being very unfavorable owing to the excessive rainfall and continuous cold, cloudy weather. In some instances nearly 90 per cent of the crop was found to be mouldy. This may account in some measure for the lack of uniformity in the data from the analyses.

RECOMMENDATIONS AND ACKNOWLEDGMENTS

For loyal and untiring support in the work of the Chemical Department I am greatly indebted to the assistants who have carefully performed the duties assigned them.

Adele Shepperd has continued to serve as Assistant Chemist in the Experiment Station for the past year, and a large share of the routine work of analysis has been done by her. I commend most cordially her faithfulness to the duties assigned to her care. I am also indebted to my assistant in the college for much analytical work during the past year. Mr. C. H. Kimberley has devoted much time during the past summer and fall to station work and I am indebted to him for much analytical data.

I desire to commend each of the assistants for the faithful performance of assigned duties.

I close my report with the statement made in submitting my last annual report.

"The one great need of the department at the present time is for rooms where chemical work can be expeditiously and safely performed without being disturbed by college exercises. The present quarters, poorly ventilated, overcrowded, improperly heated and often damp beneath the floor, are a menace to the health of all engaged in Station laboratory work."

Respectfully submitted,

E. F. LADD,

Chemist.

DEPARTMENT OF BOTANY.

To Director J. H. Worst:

SIR: The following is an outline of the work attempted under my direction in the Department of Botany during the year ended December 31, 1903. The year's efforts have been profitable in the fullest sense of the word, and I feel sure that the results obtained, and in part stated or indicated in this report, merit the close attention of the farmers of the state, indeed of every person interested in the application of botanical principles and methods of study to farm work.

CONDITION OF THE DEPARTMENT, ASSISTANTS AND EQUIPMENTS.

It is with a feeling of much gratification that I am able to state that the equipment and working force of the Department is in a most satisfactory condition. Under present conditions I feel sure that the Department will be able to make very rapid strides toward the accomplishment of the types of work that should be expected of it. The working force was placed upon an efficient basis by the return of Assistant Botanist L. R. Waldron from his leave of absence to attend Michigan University, where he took post graduate work of such nature as to fit especially himself for the duties assigned to him in the Department; and by the election of Mr. Thomas F. Manns to the position of second assistant. This places the working force, both as to teaching and Experiment Station work, upon an efficient basis. Previous to this year it had been the lot of the Department to have to train a new aid in the Station work each year, a policy which is very disadvantageous to sound advance in experimental work.

THE PLANT HOUSE—The inability of the institution to construct the buildings planned, again leaves us minus the much needed and often expected plant house for experimental work upon farm plants. However, we shall, as in the past, center our efforts upon such features of the work as may be accomplished with least detriment in the absence of such much needed appurtenances to any properly equipped botanical laboratory or experiment station for the study of plants.

In order that the labor in the Department may be systematized as fully as possible, the assistants have been assigned to definite fields of investigation, and along the lines of greatest efficiency. Mr. Waldron is in charge of those types of work directly concerned with the systematic phases of botany, including especial studies upon

weeds and forage plants and the preliminary work of constructing a garden of native plants. To Mr. Manns has been assigned supervision of the laboratory of bacteriology and special studies connected with the general field work of the Department upon plant diseases. I wish, here, to commend the efficient manner in which the different lines of investigation have been conducted during my absence. Preparatory to my leave of absence in Europe for the purpose of making a study of the conditions of flax culture in the different flax producing countries, certain definite lines of experiment were laid out to be continued here, and I find that the work has been carried out in a most satisfactory manner.

FLAX CULTURE IN EUROPE—Early in our investigations of the flax crop and its diseases it was seen that our studies would be greatly facilitated by a survey of the conditions of culture, and of the diseases which attack the crop in European flax areas, especially those of Russia and Holland. To this end the U. S. Department of Agriculture offered co-operative aid, and I was detailed for that work by our board of trustees. The work as undertaken was thus a joint one on the part of the United States Department of Agriculture and the North Dakota Experiment Station. The time occupied in this foreign study included the months of May to December inclusive. Much information was gained at first hand and numerous samples of seed were collected for future trial in the work of plant breeding.

The report of this work, by agreement, is first to be given to the Department of Agriculture. This will be of advantage because of the wider circulation possible to such publication. A report of the type desired is in course of construction. We have also begun arrangements for the proper testing of all seeds obtained in a careful, comparative manner. Only comparatively small samples of any selections of seed were brought over, but samples of these may be had by Experiment Station men, through application to the Bureau of Plant Industry at Washington, in sufficient quantities for studies in plant breeding and selection.

TESTS OF NATIVE AND OTHER GRASSES—In the fall of 1902 this department and the Division of Agrostology of the U. S. Department of Agriculture planned to conduct some co-operative experiments upon the western plains of North Dakota, looking toward rejuvenation of the grazing lands of the state.

Owing to a failure of the state to provide funds for this work as planned in the agreement, the original co-operative plan was abandoned; but many seeds had already been forwarded by the Department of Agriculture for the work. These we were allowed to retain and were used in experimental trials here at Fargo; for which full records are kept upon the plans proposed by Prof. W. J. Spillman of the Department of Agriculture.

The seeds were sown in both large and small plots, under particularly favorable soil conditions. The small plots were given very

favorable hand preparation and seeding. The large plots were given exceptionally good field handling. These last plots approximated one-tenth acre in area.

The grass seed samples were generally in good condition when received, but some of them had been gathered two or more seasons. In nearly all such cases these aged seeds failed. The age of the seed was probably an important factor. A large number of the samples failed to grow. In many cases at least this was due to the long period of dry weather following seeding. Those that germinated and succeeded in growing did so under very adverse conditions, which was a good test of their value in this state. The following perennial species came up well and grew vigorously the entire season: Meadow fescue grass (*Festuca pratensis*), rough fescue grass (*Festuca scabrella*), western brome grass (*Bromus pumpellianus*), and short awned brome grass (*Bromus marginatus*). Samples of *Bromus inermis* and slender wheat grass which were planted grew and did well, though apparently not as well as the fescue grasses or the short awned brome grass. The stand of the fescue grasses at the end of the growing season was very heavy and fine. The condition of the brome grasses was also excellent. Of the annual grasses sown, Colorado grass (*Panicum Texanum*) and tall oat grass (*Arrenatherium elatius*) were the only ones that showed promise, but the dry condition of the season seemed to be against them. Work on the grasses will be continued, and it is hoped that work upon the selection and breeding of our native grasses can be undertaken.

H. L. BOLLEY,
L. R. WALDRON.

STUDY OF ELEVATOR SAMPLES OF WHEAT—As there is a general complaint in regard to elevator grades and dockage, it was thought a good plan to obtain a number of elevator samples of grain and make a study of them. It was also desired to learn something further in regard to the distribution of weeds as determined by the weed seeds found to be present in the samples obtained from widely separate points in the state. To this end some fifty samples of wheat were obtained from different elevators. The purchasing grade and dockage was furnished in each case by the elevator agent.

In our studies the following points were determined as accurately as possible: The amount and percentage of foreign matter (dockage), the kinds and relative abundance of weed seeds, and the presence of smut balls. A certain amount of wheat was weighed out from the samples—about seven ounces—and by screening and hand picking the weed seed was entirely sorted out. This was weighed and by this means the real dockage was easily estimated. Forty-seven samples were studied, of which twenty-nine graded "one northern," thirteen "two northern," four "three northern," and one "rejected." The elevator dockages ran from one-half pound in a

single instance, up to two and one-half pounds in one case. There were more dockages at one pound than at any other figure. There were but two samples that were docked less than one pound. When the real dockages are compared with the elevator dockages, a marked difference is at once apparent. In only four cases is the elevator dockage less than the real dockage. In the remaining samples the elevator dockage was always too much, and in many cases the difference was very marked. In one sample which the elevator docked one pound the real dockage was found to be only .06 of a pound. This would be a loss of about eighty bushels on 5,000 bushels. The elevator dockage on all the samples averaged 1.26 pounds. The real dockage averaged .64 pounds, leaving a difference against the farmer of .62 pounds per bushel. Considering these figures as an average for the state, such dockage would entail a loss to the farmers of about 400,000 bushels of grain in one season. One sample which was docked two and one-half pounds contained more than eight pounds of foreign matter per bushel. In all cases in which the elevator dockage was too low the wheat was very dirty. According to samples examined, the elevators not only dock too heavily, but they dock unjustly. The cleanest wheat received proportionately, the greatest dockage, while the dirtiest wheat received, proportionately, the least dockage.

In regard to weed seeds, among the many kinds found, there were two kinds invariably present, wild buckwheat and pigweed or lamb's quarters. Russian pigweed seed (see bulletin No. 56, page 218) was found in wheat from Benson and Ramsey counties. Before this this very bad species of weed had been found only in Pembina and Cavalier counties.

Sixty-six per cent of the wheat samples contained smut balls. This would seem to indicate a certain amount of carelessness in treating seed grain, for it is well known that wheat treated with one pound of standard formaldehyde to forty-five gallons of water will prevent smut from appearing in the crop. The seed grain should be thus treated every year. If the wheat over the state was as much smutted as these samples seem to indicate, it means a greater loss to the farmer than unfair dockage.

L. R. WALDRON.

This definite test by Mr. Waldron of the quality of grain received at the elevators is directly in line with much work previously done at the Station, and is largely substantiated by our former studies. It is preliminary work of much importance and calls for close consideration. Certain it is that the balance indicated as in favor of the elevators is upon the side upon which one should expect to find it. It would be extremely bad policy for grain buyers to allow the differential to be always on the other side. It would mean a money loss to them, and would furnish a constant bonus for a careless, weed producing agriculture. The other point, however, which shows that

the dockage is quite uniformly too low in the case of poor, dirty wheat, is really the most serious matter. It will be a bad day for American grain interests when our farmers shall generally conclude that it does not pay to put well cleaned grain upon the market. It is then but a short step to the mind status of the Russian peasant, who sees no moral impropriety in the addition of a choice assortment of weed seeds, sticks, dirt and gravel.

I have always found our chief elevator grain men serious in their desires for the constant improvement of the quality of the farm output. This work merits fuller investigation on a more extended plan, and we hope to be able to continue it.

The Adulteration of Formaldehyde and the Formaldehyde Treatment of Seed Grains—This Station originated and introduced the formaldehyde treatment of seed grains for the prevention of smuts in cereals, and it has been found entirely successful for that purpose, when used in the strength recommended. It has also been found to be thoroughly beneficial to the growth of the plants from the seed, by acting as a check upon mould fungi, bacteria and various agents of decay, which otherwise prevent the young plants from drawing the full supply of nourishment from the mother seeds.

As indicated in the report of Mr. Waldron upon the examination of elevator samples of wheat, there was much smut in this state again this year.

In part this can be explained by a certain number of those who have usually treated failing to do so, thinking their wheat clean. This can never be entirely true. Smut will creep into the crop by means of incomplete treatment, sacks, threshing machines, drills, etc., and though not apparent in the seed, may be there in sufficient quantity to produce a great growth of smut during a favorable season. Also many of the farmers just come to the state are ignorant of the necessity for treating seed grain. Every farmer should take it upon himself to educate his neighbor upon these simple truths. No farmer can afford to allow his neighbor to grow disease bearing crops if, by a little advice, the disease can be done away with.

However, the most serious matter comes to our knowledge in the fact that farmers who have always successfully treated their seed grain, complain of failure; and upon investigation it is found that the druggists have sold, intentionally or otherwise, a low grade of formaldehyde, sometimes of less than half strength. I have called attention to this matter before. It is one of vital importance to our farmers. They ought to be protected. Our farmers should join with the sick in demanding that a sound law be passed making it a criminal offense to place any but pure, standard chemicals and drugs upon the market. In regard to formaldehyde, it should be specified that it shall not only be of pure quality but of stated strength. It is the intention of this Station to assist the farmer in this matter, and any firm which places low grade formaldehyde upon

the market as standard may expect to get some very hard advertising therefrom. Any farmer having cause to doubt the quality of the formaldehyde sold to him should confer with the Chemical Department of this institution.

My present advice to farmers is to buy only from standard drug houses. Do not insist upon a low price formaldehyde or take chances on the man who can sell something "much cheaper" than reputable or well known firms. Ask always for standard strength, 40 per cent formaldehyde. Don't buy it unless it has some reliable firm's name attached to the container. A farmer who has smut in his seed grain can well afford to pay well for the very best formaldehyde, but will lose heavily on his crop if he buys an inferior article.

Weeds and Forage Conditions—During the early spring two important circulars were sent out, asking set questions to be answered by farmers and stock growers especially interested. It was believed that the answers obtained would help materially in formulating plans to aid in the elimination of weed pests and to help or better the grazing conditions of the state.

Circular No. 1 sent out by Mr. Waldron, read as follows:

It is the intention of this Station to undertake a study of the range problems of this state. The present conditions of the range, the causes which have brought about their depletion and methods by which they may be brought to their former standard. In order to do this it is desirable to co-operate as far as possible with the various ranchmen of the state, and to that end the enclosed questions are sent you. Answers to these will put us in closer touch with the actual condition of affairs.

It is a well known fact that the grazing lands of North Dakota have been and are being greatly lessened in extent by the great increase of cultivated areas. As the grazing lands are decreased in acreage there is a natural tendency to overstock the remaining ranges, and thereby decrease their carrying capacity. It is believed that if the ranges that remain are properly handled they will regain their former efficiency, or even be increased in quality. It is desired that the enclosed questions receive careful consideration at your hands, and if you can give us further information along the same lines it will be deemed a favor.

QUESTIONS.

1. How long have you lived upon the range, and how much range land have you a knowledge of?
2. What is the average carrying capacity per square mile of horses, cattle or sheep on the range in which you are interested?
3. Has the capacity to carry stock been diminished within your experience, and, if so, how much, and to what causes may such diminution be attributed?
4. Are the lands near you unsuitable for profitable cultivation? If so, is this due to lack of moisture, uneven ground, or what?
5. Has any of the land that you think unsuited for cultivation been broken for that purpose?
6. What effect does such breaking have upon the land for grazing purposes? Does it eventually become as good as before?
7. Have you any treatment to recommend for improvement of the ranges where they have been overstocked?

Many very good letters were received in answer, and the studies are continued. As this is a question which may be expected to grow

in importance, the Department will be pleased to have any farmer or stockman who reads this report give his opinion upon such of these questions as he may be particularly interested in, or upon which he can give some information.

CIRCULAR NO. 2.

This circular was sent out as "Special Bulletin No. 2, Weeds," by L. R. Waldron, to which was attached a detachable leaflet of questions.

This portion of the circular read as follows:

Please answer as completely as possible the questions on the annexed sheet and send it to the Botanist, Agricultural College, N. D.

Name ....

Postoffice ....

County ....

1. Name eight or ten of the worst weeds growing upon your farm or in your vicinity. (If the names are not known, the plant sent in will do as well.)

2. From observations made in your district, what per cent loss do you estimate is done annually to the crop by weeds?

3. Of the total loss to the crop from weeds, what per cent do you estimate is due to (a) the suffocation of the growing crop? (b) What is due to robbing the soil of plant food and moisture? (c) What loss is due to dirty and degraded grain?

4. What method do you use in the eradication of weeds? Have you any special methods for particular kinds?

Underline once the following plants that grow in your neighborhood, and underline twice the plants that are a serious pest to farming:

1. False flax.
2. Hare's ear mustard—black mustard.
3. Tumbling mustard.
4. Pink cockle.
5. Water hemlock.
6. Kinghead.
7. Canada thistle.
8. Wild lettuce.
9. Russian thistle.
10. Wild oats.
11. Quack grass.
12. Sunflowers.

This weed question also will not grow stale, and as we are particularly interested in keeping informed as to the distribution of destructive or detrimental weeds, the Department will be pleased at any time to assist the farmers of the state in becoming properly informed as to the nature of the weeds which trouble them.

If you desire information in regard to plants growing on your farm, write to us, or send in a specimen plant. In all cases when plants are sent in it is of direct help to us, for we learn when harmful plants are being introduced and the distribution of the ones already here. Send in the plant in an unsealed package with your name and address on the outside. The postage is one cent per ounce. In the accompanying letter give your opinion of its weedy or other properties, with other information you consider of interest.

AN OBJECT LESSON IN WEED SEEDS—Strange as it may seem to many, the farmers, the very persons who should know kinds of weed seeds do not generally know the plants upon which the com-

mon sorts of weed seeds which are found in grain, grow. To help them in this matter, Mr. Waldron, this season, prepared an authentic set of weed seed samples of twenty-six of the worst weeds. The seeds were enclosed in small bottles labeled with the proper name of the weeds, and all enclosed in a neat cloth bound case so that the seeds are ready for easy examination. With such a case before him a farmer can easily learn for himself the kind of weed seeds to be found in his grain.

The list of samples prepared was as follows: Quack grass, wild oats, cheat, pigeon grass, wild barley, wild buckwheat, Russian pigweed, lamb's quarters, Russian thistle, red-rooted pigweed, corn cockle, pink cockle, yellow mustard, Shepperd's purse, false flax, hare's ear mustard, peppergrass, ball mustard, tumbling mustard, pennycress, water hemlock, kinghead, Canada thistle, marsh elder, prickley lettuce, sunflowers. The set was sold to the farmers at the cost of preparation and was soon exhausted. Others will be prepared during the coming season.

The weed and native plant seed collection prepared for reference in the Department was increased during the year by many numbers.

The Agricultural Survey—The regular lines of investigations in connection with the agricultural survey have been advanced along previous lines, certain types of plants and certain definite areas being studied. Three short excursions were made for the purpose of studying stock poisoning plants. Mr. Waldron spent a week studying range conditions in Mercer county, especially along the Knife river; and further collections of native plants were made at Minot, Towner, Bottineau and Walhalla.

The Publications of the Year—Early in the year much work was given by the head of the Department to foreign correspondence and to the study of flax seed samples, samples of flax straw, etc., sent from foreign flax growing areas. This was a requisite step preliminary to the undertaking of the foreign investigations, thus making it possible to receive the necessary aid from the United States Department of Agriculture. This work proved very instructive, and a full report of the same was made to the head of the Bureau of Plant Industry. Later this will, in part, be embodied in the general report upon that work, and much of it may be used in our regular bulletins.

Of the regular publications, the following bulletins have been sent out: (1) Bulletin No. 55, "Flax and Flax Seed Selection," by H. L. Bolley, March, 1903; (2) Press Bulletin No. 2, "Seed Wheat," by H. L. Bolley, March, 1903; (3) Press Bulletin No. 3, "The Way to Avoid Flax-sick Soil—Select Seed," by H. L. Bolley; (4) Special Bulletin No. 2, "Weeds," by L. R. Waldron, May, 1903; (5) Press Bulletin No. 10, "Treat Your Seed Corn," by L. R. Waldron, May, 1903; (6) Bulletin No. 56, "Noxious Weeds and How to Kill Them," by L. R. Waldron, June, 1903; (7) Bulletin No. 58, "Some Stock Poisoning Plants of North Dakota," by L. Van Es and L. R. Wal-

dron, December, 1903. This last named bulletin was prepared in colaboration with Dr. Van Es of the Veterinary Department. In most cases the demand for the newspaper press bulletins continues after the issue is exhausted. If it is thought desirable, these will be collected and re-edited to form a composite bulletin of the regular issue. I deem it desirable to do this, also, as a matter of record of such press bulletin work in the Department.

THE WORK OF MR. THOMAS MANNS—The data for the report of the year upon the remaining subjects here reported upon are furnished from notes taken by Assistant Botanist Thomas Manns. The subjects under consideration arise from the continuation of regular lines of investigation planned and in part executed in previous years.

WILT CONTROL BY CROP ROTATION ON ROTATION PLOT NO. 30—This is the third season of this work. The crops used in previous years, methods of work and the observations made may be learned from the Thirteenth Annual Report, pages 34-36. The record of the year 1903 is as follows:

Bed No. 1. April 16th, sown with Kubanka wheat, ground not respaded. July 25th a heavy crop matured, strong, healthy and very regular.

Bed No. 2. April 16th, sown with a prairie mixture of grass. July 25th a nice, even, strong growth of grass.

Bed No. 3. Sown with brome grass, 1902. Brome grass second year. July 20th cut a heavy, thick crop of brome grass.

Bed No. 4. May 16th, sown with a mixture of forty samples of flax seed from different European countries. One half of the seed was treated with formaldehyde, three parts to 1,000; one-half not treated. July 31st, nearly all plants, whether from treated or untreated seed, died of wilt. Few plants showed immune qualities, but more resisted than in case of mixed Amercan seeds in bed 5.

Bed No. 5. May 16th, sowed with mixed flax seed from a mixture of some sixty different American samples of seed obtained from various parts of the three northwestern states, one-half treated with three parts in 1,000 formaldehyde, and one-half not treated. July 25th, nearly all plants dead of wilt, both treated and untreated. Very few showed immune qualities.

Bed No. 6. May 16th, sowed Velvet Don wheat, ground not respaded. July 25th, a very heavy crop of wheat matured.

Bed No. 7. May 27th, sowed corn, yellow dent, fodder. This is the second year with corn. July 25th, corn over five feet high, a fine stand, ears plentiful and large. Not a single hill or plant died.

Bed No. 8. May 16th, fifty-seven individual European samples of flax seed were sown to test wilt resisting properties. Many samples, nearly 70 per cent, showed very little if any resisting qualities. None showed perfect immunity. About six samples showed 30 to 45 per cent or more of immune plants. About twelve samples showed from 5 to 15 per cent of immune plants.

Bed No. 9. May 22d, sowed south half with twenty-five American individual samples to test immune qualities. Practically all samples died, except a few in sample No. 72.

Bed No. 9. May 16th, sowed the north half of bed No. 9 as follows: Six rows with seed of the largest hand selects from flax seed grown upon rotation plot No. 31 in 1902, a diseased plot. Rest of bed was seeded to large, select seed from same source, selected by screen method. Object, to test immune qualities. Results, about 98 per cent wilted and 2 per cent matured seed.

Bed No. 10. May 29th, sowed south two-thirds of bed with seed from original immune selected plants. To test immune qualities, sowed checks with them. Conclusion: Nearly all of these original immune plants showed some immune qualities. Several showed almost perfect immunity, and matured an even and full crop. All checks died quickly. The third generation, grown from second generation of immune plants, matured in greenhouse in winter of 1902-1903, which were raised on this plot showed about same resistant qualities as did the second generation grown side by side on this same bed.

Bed No. 11. May 26th, planted the south half with largest screen selected flax seeds obtained from the diseased 1902 crop, from rotation plot No. 31, and the south half of the north half with the smallest screened selects from seed of same source as last, and the remainder of the north half with dark colored, dark pointed or "scaly" selects from seed of same source. Object: To test the immune characteristics of each. *Conclusions:* I estimated about 1-200 of largest selects were immune and matured seed, about one-fiftieth of the plants from the smallest selects matured seed, and of those from the "scaly" seeds about one-fortieth matured seeds.

Bed No. 12. This bed still remains idle as to cultivation. Practically, it has now almost reached native prairie form again, that is, the weeds and grasses which it produces are perennial.

The culture work when last taken on the different plots show that *Fusarium lini,* yet persists in all of the beds, perhaps in least abundance in bed 12.

The field experiments this summer on beds 4, 5, 8, 9 and 11 show that the soil is yet thoroughly infested with the wilt disease, and speaks badly against the hope that any short seried rotation will prove to be effective in ridding the soil of the parasite. There was no reliable evidence indicating that wilt infested soil was detrimental to the growth of the other farm crops tried. All crops grown in 1903, viz.: Macaroni wheat (two samples), corn, prairie grass and brome grass, all showed a fine growth, in no way being affected by the sick condition of the soil. Treating flax seed does not prevent the fungus (flax wilt parasite) which is in the soil from attacking the seed upon germination. The plants from common seed, whether from treated or untreated seed, died with equal speed.

In 1900, because of previous continuous cropping with flax, bed No. 10 was found to be unable longer to support common flax. This year, though it has been seeded continuously to flax since 1900, it was found to be able to furnish abundant nourishment to produce a strong growth of the flax from our select immune seed. This is the final proof that flax cropping, of itself, does not destroy the chemical fertility of the soil, or cause other mechanical or physical condition of the soil, accounting for flax failure in such soils. It is now quite demonstrated that the difficulty is alone due to the wilt fungi.

The Work Looking Toward Procuring Strains of Flax Seed Immune to the Wilt Disease or Diseases—(a) European mixed samples in bed No. 4 showed a much larger percentage of immune plants than the American mixed samples in bed No. 5. (b) European individual samples in bed No. 8 showed a much larger percentage of immune plants than the American individual samples in bed No. 9. This would seem to bear out the observations made in our laboratory and greenhouse studies of 1902, represented in the Thirteenth Annual Report, pages 55 and 56, where it was also suggested that it might yet be possible to find an immune variety or strain in considerable bulk. The large number of different samples selected while in Europe this summer will make it possible to test this subject thoroughly. (c) The seed from our original immune selected plants showed up exceedingly well, several showing almost complete immunity and producing fine crops, others showed only partial immunity. The checks all died, except one individual plant. The third generation, raised from greenhouse grown seed of immune selects, showed resisting qualities about the same as seen in the second generation from seed of field grown immunes. (d) Immune plants were in most cases attacked apparently as freely by rust (*Melampsora*) as common flax. (e) It seems probable that it may be possible to obtain, by selection, an immune strain from almost any general sample of flax seed.

In connection with the selection work, as practiced on a field plan, the work, as conducted on the diseased area known as rotation plot No. 31, gave good opportunity for observation. It is learned that this cannot be accomplished well unless some means is taken to hold the growth of the weeds in check. Left under ordinary field conditions, the surviving or resistant plants being few upon the ground, are soon overcome by the growth of weeds. The smaller select seeds and the more diseased and sickly looking seeds selected from the diseased crop of 1902 on rotation plot 31 showed a larger percentage of resistant plants than the selected best seed from same sample. (See, also, summary, bed No. 11, under wilt control by rotation work.)

In the study of the growths from the seed from individual select plants, it is interesting to note that all growths from the seed of such resistant plants, showed some powers of resistance. The check growths from common seed always died early, usually at from one to two and one-half inches in height, while those from the seeds

from the immune selects, which failed to mature seed, often reached heights varying from four to twenty inches before succumbing to the wilt. The following table will indicate the results obtained in this work with the seed from sixty mother plants (selects). The amount in grams shows the yield of seed, the number is the name of the mother plant:

No.	Crop.	No.	Crop.	No.	Crop.	No.	Crop.
1.	25 grams.	16.	....	31.	....	46.	17 grams.
2.	....	17.	7 grams.	32.	29 grams.	47.	....
3.	16 grams.	18.	45 grams.	33.	44 grams.	48.	40 grams.
4.	32 grams.	19.	....	34.	5 grams.	49.	19 grams.
5.	62 grams.	20.	....	35.	....	50.	7 grams.
6.	....	21.	46 grams.	36.	11 grams.	51.	7 grams.
7.	....	22.	28 grams.	37.	....	52.	47 grams.
8.	....	23.	59 grams.	38.	....	53.	42 grams.
9.	10 grams.	24.	....	39.	15 grams.	54.	35 grams.
10.	72 grams.	25.	59 grams.	40.	27 grams.	55.	....
11.	....	26.	....	41.	46 grams.	56.	7 grams.
12.	10½ grams.	27.	....	42.	....	57.	24 grams.
13.	62 grams.	28.	66 grams.	43.	....	58.	24 grams.
14.	21 grams.	29.	....	44.	21 grams.	59.	27 grams.
15.	....	30.	49 grams.	45.	56 grams.	60.	14 grams.

Some sixty samples of flax seed were obtained from various flax growing districts of Europe. About one-fourth ounce of each kind of seed was sown upon wilt infected soil—one row sixteen feet long. The following table shows the number of individual European samples which showed resistant qualities and the amount of seed matured by each:

Sample No. 22 matured 96 grams of seed.
Sample No. 26 matured 11 grams of seed.
Sample No. 27 matured 39 grams of seed.
Sample No. 29 matured 46 grams of seed.
Sample No. 31 matured 52 grams of seed.
Sample No. 35b matured 30 grams of seed.
Sample No. 35g matured 16 grams of seed.
Sample No. 36 matured 29 grams of seed.
Sample No. 41 matured 27 grams of seed.
Sample No. 44 matured 24 grams of seed.
Sample No. 45 matured 31 grams of seed.
Sample No. 47 matured 21 grams of seed.
Sample No. 52 matured 99 grams of seed.
Sample No. 54 matured 112 grams of seed.
Sample No. 56 matured 80 grams of seed.

These strains will be tested again next season, and a full report upon origin of the seed and the character of the results may better be given in bulletin form.

We have also collected this year 759 grams of seed, matured upon a diseased area from a mixed lot of European grown seed.

By hand hoeing and weeding, enough plants matured in a field crop on rotation plot No. 31 to furnish one-half bushel of seed. This will be used again on the same diseased land next year.

In all, we thus have a good supply of seed for further work upon this question, and the results of our experiments have been such that there can now be no doubt that we shall ultimately be able to develop a wilt resisting strain of flax.

Frost Resistant Flax—Some of our observations in previous years led us to think that it might be possible to select a strain of flax which would have somewhat greater resistance to frost, both spring and fall, than that shown by the present common crop. An extended experiment was undertaken this past season. Thirteen plantings were made, beginning April 13th and ending July 20th, about one planting each week. Plantings were made each time from several different types of seed—mixed American seed, mixed European seed and numerous individual samples.

The season proved very unfavorable for a test of this work. The spring was backward and droughty, so that, excepting the first planting, all lay in the soil until spring frosts were past; that is, only the first planting was up so as to catch the spring frosts; hence on the spring frost selection all results had to come from this planting. The strongest frost was April 30th, when nearly all of the first plantings were up. The temperature registered 14 degrees Fahrenheit, making 18 degrees of frost. The frost resisting qualities of many of the strains appeared to be quite good. About two-fifths of the plants from the European mixed seed in planting No. 1 stood the above frosts. These plants were up one inch high and had only seed leaves at this freezing. A much less number of the American mixed flax stood the above frosts. By estimate less than one-fifth stood this test. Of the European individual samples, several showed fine qualities of resistance.

Some of the individual samples of American grown seed showed much better results than one would have expected from observing the effects of the frost on the mixed sample of seed. There was from one-third to one-half a crop in some cases, after the above named spring freezing. Some plants entirely lost the seed leaves and yet continued to grow from the plumule.

The work indicates that the idea of selecting to gain plants of resistant powers against spring frosts is worthy of further effort. The work in the autumn also suffered because of an unfavorable season for the purpose. The growth from the seed in the spring was backward until late, then the seed from all plantings, following a light rain on July 2d and 3d, came along as if of one date of planting; and, again, owing to the cool growing weather of July and of August, all plantings after July 9th failed to mature seed. No reliable or even probably worthy selections were possible under these conditions. Plantings Nos. 2, 3, 4, 5, 6, 7, 8, 9 and 10 all escaped both spring and autumn frosts. Plantings Nos. 11, 12 and 13 received fall frosts, but had been so delayed by the slow growing conditions of July and August that all were finally caught and de-

stroyed by heavy freezing before maturing any seed. Several selections of seed were made from growths in planting No. 1.

In conclusion it may be said that frost destruction of this crop is so great each spring and fall that, slight as were the results of these efforts, it seems that further trials should be made.

SELECTION OF FLAX FOR A SHORT SEASON STRAIN—Plantings were made from numerous different European and American samples upon different dates. These were studied as to their growth period. Fourteen selections of seed were made, eleven of which were from the European samples. It is evident that something can be accomplished along this line. Samples differed in the length of the growth period as much as two weeks. It was observed that American grown samples of flax seed quite uniformly demanded a longer vegetation period than the European samples.

COMPOSTING FLAX STRAW TO DESTROY SPORES OF THE FLAX WILT FUNGUS—In October of 1902, small, compact bundles of wilted flax straw, bearing spores of the disease, were placed into a newly made compost heap of barnyard manure. August 29th, one bundle was removed for study. The straw in parts was well rotted, in other parts it appeard as if burned by the composting or had dry rotted. Various culture methods were tried upon this material, but no growth of *Fusarium* was obtained in any case. Further tests will be made at another time. Examinations will also be made into the surrounding manure.

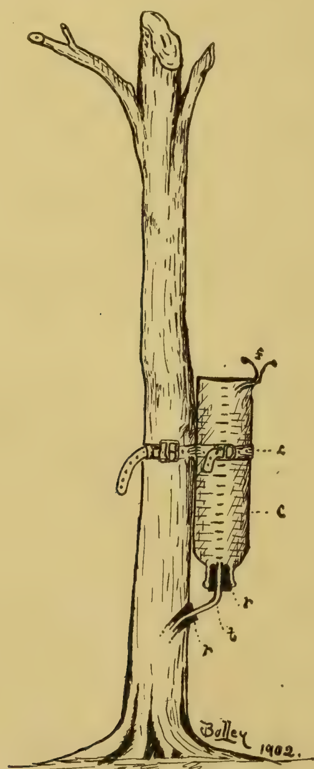
SOIL FUNGI AND THEIR RELATION TO FLAX WILT—Numerous pure cultures of fungi have been made from the soil of flax sick areas, from diseased flax seed samples, American and European, and from materials collected by H. L. Bolley in Belgium and Russia. These cultures were used in various infection tests, in the laboratory and in the field. A full report of this work will be given to a later publication in connection with thesis work by Mr. Manns. It is sufficient here to note that all of the work confirms our previous conclusions upon the destructive nature of *Fusarium lini,* and also of an observed undescribed species of *Collelotrichum.*

TREE FEEDING AND TREE MEDICATION—Everyone has perhaps during his boyhood days met the old farmer who grew the big prize winning squash for the county fair by feeding it sweet milk or perhaps water, which it sucked up through a cut off branch nearest the joint to which the squash was attached. I do not know how many persons have actually ever seen the work of feeding the squash in operation. I never was able to witness the performance, though being curious, as a boy, I often tried to make the squash feed. One also often sees cursory notes in farm papers to the effect that trees will suck up moisture through broken branches which are dipped in a pail of water, etc., but I know of no serious attempts to test the merit in these various claims. My curiosity remains in the matter, and having as early as the summer of 1896 made an attempt at tree feeding and medication which acted in a most finished and

destructive way upon six apple trees, I determined in the spring of 1902 to give the matter a serious test. (See page 61, Thirteenth Annual Report.)

The economic purpose of such a test is evident: (1) Trees take up food matters of a definite type in water solutions; thus, if trees can be directly fed, aside from the natural source, then we can learn *what* to feed, and *how* and *when* to do it. (2) Trees are subject to two sorts of disease, (a) simple physicological derangement due to faulty nutrition, and (b) parasitic (animal and plant); thus, if plants may be directly fed, then we may, perhaps, subject them to such direct or internal feeding as to correct faulty conditions of nutrition, and, perhaps, so medicate the food supply as to relieve or guard the plant against parasitic attacks.

It was found at once, upon a properly conducted trial, that trees will take up water solutions in large quantities, and that the work can be done with ease without injury to the trees.



Cut No. 1. Shows the manner of attaching the bottle or container used in feeding trees; *f*, a small funnel for filling the container; *l*, strap clasping bottle and tree; *c*, the bottle with a scale so arranged as to show the rate of feeding; *r*, rubber corks; *t*, a glass or other tube connecting container to a small auger hole in the body of the tree.

The method of feeding developed is simply to bore a small hole into the body of the tree until the heart wood is reached. This is at once filled with water to exclude air. Then a feeding flask or bottle is attached to the opening as shown in the accompanying cut, by a rubber or other close connection.

The work as conducted during the growing season of 1902 and again in 1903 is too extended for detailed account here. We have yet also much to learn before ready to write. A full report of the work to date is being summarized, and when further points are cleared up we think that we shall have some results which will quite be worth while. Here we can only say that there have been surprises at every stage of the work, and, at least, we are getting some education as to what a tree can do when it once decides to "take to the bottle."

During the season of 1902, eleven trees were under consideration for a period of forty-seven days, and eleven different feeding solutions were used.

In 1903, three of these trees were continued in the same trials for the same period of time as in 1902. Three new trees were placed under test, and three new test substances were used.

The trees used in these experiments were cottonwoods and apple trees.

We have made numerous observations upon the work, some of which are easily explainable, others need further research. The work has given returns beyond our best hopes. It is certain that along this line of work we shall be able to get tangible results looking toward the solution of many physiological problems affecting our present knowledge of plant life. Thus, by this way, persistently pursued, we may yet learn much to influence our theories regarding the ascent of sap in trees, assimilation and translocation of food matters, fruit setting, transpiration, etc.

The following are a few of many observations recorded: (1) Other conditions being equal, a tree seems to feed at about uniform rate day or night. (2) The rate is varied by many circumstances, as for example, (a) atmospheric temperature, (b) atmospheric moisture, (c) water supply in soil, (d) strength of the solution applied, etc. (3) Trees vary in their rate of feeding (a) with regard to kind, and (b) with regard to their natural strength of growth, size, etc. (4) Chemical substances are carried to the most distant parts of the tree in a few hours; thus in ten hours substances could be detected (*microchemically*) in the topmost twigs of cottonwood trees, thirty to forty-five feet high. (5) Diffusion is not rapid radially in cottonwood trees, that is, the movement of the liquid is most rapid and effectually evidenced vertically. (6) The killing effect of strong solutions appears to be in a direct relation to strength. (7) As to direct effect upon a tree, (a) one may kill a tree to its furthermost root, (b) check growth, or (c) accelerate growth by these direct methods of tree feeding. (8) As to the effect upon

parasitic disease the work is yet inconclusive. In the cottonwood we have not been able to prevent the occurrence of the usual annual attack of rust (*Melampsori*). In the test on apple blight (pear blight), they have as yet been too limited to even hope for results. In one trial in the summer of 1896, six trees which were blighting badly were internally treated, five died at once, the sixth completely died on one side to past the center. It has not blighted since, but is a healthy producer of fruit. This may, perhaps, be but a co-incidence. In the trial of 1902, the work was undertaken after the blighting had started, and had apparently no effect in preventing the occurrence of blight again in 1903. It is possible that the treatment, in part, may have been responsible for an apparent increased setting of fruit during the season of 1903. (9) Under certain conditions trees may not only fail to feed from the bottle, but may show a back flow into the bottle, even when in full foliage.

This statement is, perhaps, sufficient at the present time. It was intended to withhold a report upon this work for one or more years yet, but, by inadvertance, a friendly observer has lately brought the matter up for discussion before the North Dakota Horticultural Society, and for this reason a preliminary statement, at this time, is thought advisable.

Respectfully submitted,

HENRY L. BOLLEY,

Botanist.

AGRICULTURAL DEPARTMENT.

To Director J. H. Worst:

SIR: In submitting to you the Fourteenth Annual Report of the work of this department, it is necessary for me to recount the changes in the force of experimenters and in the list of teachers in the agricultural division of the College, which has caused a sad reduction in the working efficiency of our force.

The position left open by the resignation of Professor Ten Eyck has recently been filled by the election of Professor J. C. McDowell, and the position left vacant by the resignation of Professor C. J. Zintheo has been filled by the appointment of Mr. Olaf Nordby, a former graduate of this institution. It is also my duty to report to you that the resignation of Mr. H. M. Ash as farm foreman left a vacancy which has been filled by the election of Mr. Nicholas Grest. Mr. L. F. Seneco, who has been employed in the seed breeding and variety testing work as expert help for about eight years, handed me his resignation last July. A number of other changes in the force of expert field men have occurred during the year. Most of the vacancies have been caused by private firms offering our help more than the limited resources at our command would warrant us in paying.

I am aware that the state has never co-operated with the government in the support of the Experiment Station, and I realize that by reason of that fact we are not prepared to compete with similar institutions in other states in securing and retaining the services of expert men, as the substantial advance in income and position which has been tendered these young men bears evidence.

The writer's time has been sadly decimated by the aid which it has been necessary to give these new men by reason of their being unfamiliar in most cases with Experiment Station and College work and from the conditions which prevail in this state being so different from those which have surrounded young men whose experience has been altogether in states further east.

I have found also that men must be allowed to follow their individual plans to a certain extent if they are to be efficient and original investigators, all of which limits the total net results to the Station when changes are frequent.

One of the strongest recommendations which I would urge upon you is the necessity of providing sufficient funds to retain the services of suitably qualified experimenters. I would not recommend the

indiscriminate advancement of them either in salary or recognition, but there seems to be no way of retaining such help except by paying as much for it as other institutions are willing to do.

Many side duties fall upon the members of this department with the development of the institution. Farmers' excursion parties almost completely occupy the time of the entire force during the ten days to two weeks which it requires for them to be shown about the grounds, and for the work of the institution to be explained to them. The department also gives a considerable amount of time to the various agricultural fairs of the state in the way of expert judging, which, although an effective and advisable means of disseminating information, breaks in upon the time of the Station workers and reduces their capacity for experimental results.

The College and school classes have grown so large that they require additional work, owing to the large numbers which must now be accommodated. During the past year it has been necessary in some instances to divide classes and have the teacher do double and in some cases treble duty to accommodate those who applied for agricultural instruction. The ten day stock and grain judging school is a new feature which almost completely occupies the time of three men from this department during the ten days or two weeks, and causes a cessation of experimental work during that period in so far as those who are actually teaching in that school are concerned. The conducting of excursion parties of animal husbandry students to Chicago and St. Paul at another season of the year represents a valuable feature of educational work for our younger farmers, but it also takes time from College work. The grain and stock growers' convention, an occasional farmers' institute and other meetings of a similar nature are additional features of the season's work, which do much toward disseminating the information gathered by the Station workers and are valuable features of the year's results, but they reduce the capacity of the data gathering force of workers.

The Edgeley Sub-Station requires practically all the time of Supt. O. A. Thompson, while the writer finds it necessary to make frequent trips and to spend a considerable portion of his time in planning and directing the important work that is being carried on at that point.

Another feature which requires a considerable expenditure of time on my part is the answering of specific agricultural questions by direct correspondence. The 1,928 typewritten pages in my copy book for the twelve months of 1903 bear mute testimony of the expenditure of a considerable portion of my time for the year. I have spent a large amount of time in an attempt to bring out the merits of macaroni wheat as a market product with apparently good success, although the effort required a great deal of time and a vast amount of energy.

I have called attention to the above items as a means of getting the fact before you that the work required of this department is very different from that which was expected of it ten or even five years ago.

A pressing need of the department is a suitable building for the storage of seeds. The Station and the state is still suffering from the loss which it sustained in the destruction by fire of a number of strains of improved grain in the winter of 1901. There is a strong demand on the part of crop producers in this state for the seed of well bred strains of field crops. The Station has produced stocks of seeds by breeding and selection which have superior merit, and which would effect marked improvement if they could replace the strains which are now in the hands of the people. With our present storage facilities it is impossible to distribute or increase in quantity new seed as rapidly as its improvement by breeding and selection would warrant. For example, two well bred varieties of potatoes have been increased in quantity until the Station could grow enough in a single season to give the potato growers of the state a good start of seed. The Station has no place to store potatoes except in primitive earthen pits in the field, and such an uncertain process of carrying them through the winter makes the distribution of seed impracticable. The demand for improved seed from the Station is unabating, and the reports which I have received from the farmers who have secured good strains of seed from us during the past few years indicate that they are rapidly disseminating them among their neighbors, and that in a short time these strains will replace the old and less valuable kinds which were formerly grown in the state. I have been gratified and really surprised that they have met with such favorable reception and that they have been disseminated so rapidly.

The co-operative aid of the United States Department of Agriculture in the seed breeding work of the Station accounts largely for the ability of the Station to produce good strains more rapidly than we are able to increase them in quantity and distribute them. The department officials with whom I have discussed the matter, and who represent the government's side of the co-operative work, seem disappointed when they find that the seed which their co-operative aid helps to produce cannot be increased and placed in the hands of producers as rapidly as it would be possible to do with good equipment. The United States Department of Agriculture proposes to make a substantial increase in the co-operative aid which it will give to the seed breeding work during the coming year. The faith which this increased aid implies places us under obligation to secure better storage facilities, in order that the state may obtain the fullest advantage which it will be possible to secure from the work.

J. H. SHEPPERD.

PLANT BREEDING.

The work of plant breeding in co-operation with the Bureau of Plant Industry, Department of Agriculture, Washington, D. C., has been carried forward in much the same manner as that which was reported upon a year ago. Something over 50,000 plants were matured in the plant breeding nursery in 1903, which included the following stocks: Wheat, oats, barley, flax, buckwheat, millet, alfalfa, red clover, corn, potatoes, brome grass, slender wheat grass and timothy. The distribution work has also been continued, the Station having sent out thirty-five and three fourths bushels of corn to twenty-eight different growers, sixty-eight bushels of macaroni wheat to eleven growers, and 300 pounds of slender wheat grass to four growers.

The importance of the seed breeding and distribution work has been so regularly presented in my past reports that I will only add herewith the detailed statement of the names of the stocks or strains of plants which we have grown during the past season, and in a brief form the objects sought in each case.

Breeding for high protein content in corn has been continued in co-operation with the Chemical Department of the Station, and while it is not yet carried far enough to be worthy of very great consideration, it is nevertheless an important piece of work, which is being continued, with its accumulating results, as rapidly as passing time and the facilities of the Station will permit.

The checking up of our co-operating grain growers and the personal conferences which Mr. Schollander is able to have with them in the interests of the plant distribution work during the progress of his tour of the state in presenting the subject of seed improvement upon the farmers' institute platform constitutes a valuable adjunct to the plant breeding and seed distribution work. The department is greatly benefitted by the prominence which he gives the work in his addresses to our farmers and in the reports which he is able to secure from them by means of personal visits. It also enables the Station to secure the co-operation of suitable men in carrying on the work of distribution. I find that those who secure grain from the Station distribute it widely by selling to their near and remote neighbors, thus vastly extending the good which is effected by the plant breeding work.

Fife, 18 stocks fixed type	4,500 plants
Blue stem, 36 stocks unfixed type	3,400 plants
Cross breds	2,700 plants
Macaroni	500 plants
Total	11,100 plants

Whorled oats, 6 stocks fixed type	3,100 plants
Side oats, 1 unfixed type	800 plants
Cross breds	100 plants
Total	4,000 plants
Six-rowed barley, 4 stocks fixed type	1,600 plants
Two-rowed barley	900 plants
Total	2,500 plants
Flax bred for seed, 12 stocks	3,000 plants
Flax bred for fibre	1,400 plants
Total	4,400 plants
Buckwheat, light colored seeds	500 plants
Buckwheat, dark colored seeds	900 plants
Buckwheat, red type of seed	100 plants
Total	1,500 plants
Millet for seed, 11 stocks of millet	3,000 plants
Millet for fodder	400 plants
Millet for fodder and seed	200 plants
Total	3,600 plants
Turkestan alfalfa	1,496 plants
Grimm alfalfa	1,394 plants
Red clover	1,462 plants
Total	4,352 plants

Three varieties of potatoes are being selected for high starch content. The results from two years' work are promising.

Ten ears of Minnesota King corn, selected for high protein and ranging in the proportion of proteids from 14 to 15.44 per cent, were grown as a continuation of the trial.

Six ears of Golden Dent corn, ranging in proteids from 12.06 to 14 per cent, were selected and grown in the way described above for the Minnesota King strain.

Twenty-five ears of Golden Dent corn were planted in separate rows, that the earlier, better grain and fodder yielding progeny might be selected and perpetuated.

VARIETIES OF WHEAT.

Forty-eight varieties of wheat were sown on the dates of May 2 and 4, 1903, at the depth of two inches. The fife and blue stem strains were sown at the rate of five pecks per acre, and the macaroni varieties at the rate of six pecks per acre. The larger size of the berries of macaroni wheat makes it necessary for the grain to be sown at a higher rate per acre than the fife and blue stem varieties require. It is scarcely probable that any greater number of seeds are distributed upon an acre of ground in seeding macaroni at the rate of

six pecks per acre than results from seeding fife and blue stem varieties at the rate of five pecks per acre. The varieties of wheat were sown upon one-tenth acre plots with eighteen inch intervening alley ways, upon ground which had produced corn in 1902. The ground was double or cross disced in the spring, and harrowed once with a peg-tooth harrow. The soil was very wet at the time of preparing it for wheat seeding, which interfered with the work to some extent. To secure good and uniform results in seeding the grain, the large corn roots or stubs which came to the surface were thrown aside in front of the drill. For field seeding such a process would not be necessary, but where results are to be compared it is advisable to have the conditions of covering uniform. A double disc Dowagiac drill was used in seeding the varieties of wheat. A shoe drill would doubtless have caused some trouble by dragging the corn stubble and clogging. By the 12th of May the grain was up on all the plots of ground and made a good showing. A week later the color was good, the grain showed a thrifty appearance and was free from weeds. The table furnished herewith gives a full record of the facts obtained in the trial:

TABLE I.—VARIETIES OF WHEAT—CROP OF 1903.

Bulletin No.	Variety	Class	Where From	Days Maturing	Length of Stem—In.	Length of Head—In.	Bearded, Smooth or Velvety	Grade: Weight Per Bu.—Pounds	Grade: Grade	Grade: Yield Per Acre—Bushels	Grade: Average Yield—Crop '02-'03
197	Preston	Crossbred	Prof. Wm. Saunders, Ottawa, Can	97	40	3	Bearded	61½	1N	38.8	31.9
250	Sel Glyndon (818)—Minn. 155	Fife	Minn. Experiment Station	102	38	2¾	Smooth	60½	1N	37.9	31.0
260	Selected Minnesota 293	Fife	Minn. Experiment Station	102	44	3	Smooth	60½	1H	38.2	31.9
261	Experiment Station No. 66	Fife	Jno. A. Davis, Buxton, N. D.	102	44	3	Smooth	60	1N	38.5	30.8
254	Pillsbury	Fife	Northrup, King & Co.	102	44	3	Smooth	59½	1N	37.1	30.9
253	Saskatchewan	Fife	Northrup, King & Co.	102	42	2¾	Smooth	61½	1H	34.4	29.2
258	Selected Minn. No. 288	Fife	Minn. Experiment Station	100	42	3	Smooth	61½	1H	40.8	33.3
257	Selected Minn. No. 285	Fife	Minn. Experiment Station	104	41	3¼	Smooth	61½	1H	41.3	34.4
286	Wilcox	Fife	W. W. Kempton, North Dakota	102	43	3½	Smooth	60½	1N	38.9	30.8
236	Wellman's	Fife	Exp. Farm, Brandon, Man.	102	46	3½	Smooth	60	1H	42.3	32.5
288	North Dakota—crossbred	Fife	North Dakota Exp. Station	102	42	3	Smooth	60¾	1H	41.6	31.6
290	North Dakota—crossbred	Fife	North Dakota Exp. Station	102	42½	3¼	Smooth	61¼	1H	44.4	34.9
295	North Dakota—crossbred	Fife	North Dakota Exp. Station	102	40	2¾	Smooth	61	1H	36.5	29.7
252	Sel. McKendry's—Minn. No. 181	Fife	Minn. Experiment Station	104	42	3	Smooth	61½	1H	44.5	34.2
151	Glyndon No. (711)	Fife	Minn. Experiment Station	101	39	2¾	Smooth	58½	1N	43.4	....
292	Canada	Fife	Geo. Springsted, Crystal, N. D.	101	40	3	Smooth	58½	1N	37.7	....
293	Sel. Rystings—Minn. No. 171	Fife	Minn. Experiment Station	102	42½	3	Smooth	57¼	1N	42.3	....
294	Selected Powers	Fife	North Dakota Exp. Station	101	38	2¾	Smooth	57½	1H	41.5	....
295	Selected Powers	Fife	North Dakota Exp. Station	101	38½	2¾	Smooth	60½	1N	42.1	....
296	Selected Glyndon (811)	Fife	Minn. Experiment Station	104	38½	2¾	Smooth	59	1H	41.5	....
297	Selected Glyndon (753)	Fife	Minn Experiment Station	104	44	2¾	Smooth	58	1N	29.2	....
289	North Dakota—crossbred	Fife	North Dakota Exp. Station	102	43	2¾	Smooth	61	1H	32.5	30.2
298	North Dakota—crossbred	Blue Stem	North Dakota Exp. Station	104	43	3	Velvety	59¾	1N	34.8	....
299	North Dako a—crossbred	Blue Stem	North Dakota Exp. Station	100	41	3	Velvety	61¼	1H	35.8	....
262	Haynes' Pedigree	Blue Stem	L. H. Haynes, Fargo, N. D.	104	42	3	Velvety	60	1N	36.7	30.4
263	Marvel	Blue Stem	John A Salzer Seed Co.	104	43	3¼	Velvety	60	1N	37.7	29.4
264	Haynes' Minn. No. 51	Blue Stem	Minn. Experiment Station	104	45	3	Velvety	60½	1N	39.3	30.2
265	Bolton's Minn. No. 146	Blue Stem	Minn. Experiment Station	104	48	3¼	Velvety	60	1N	43.2	30.3
267	American	Blue Stem	Wm. Rennie, Toronto, Can.	104	48	3	Velvety	60	1N	40.3	29.9
300	North Dakota—crossbred	Blue Stem	North Dakota Exp. Station	104	46	2¾	Velvety	60½	1N	39.1	....
287	Selected Haynes	Blue Stem	North Dakota Exp. Station	104	48	3	Velvety	56½	1N	47.3	35.5

TABLE I.—VARIETIES OF WHEAT—CROP OF 1903—Continued.

Bulletin No.	Variety	Class	Where From	Days Maturing	Length of Stem—In.	Length of Head—In.	Beardless, Smooth or Velvety	Grade: Weight Per Bu.—Pounds	Grade: Grade	Grade: Yield Per Acre—Bushels	Grade: Average Yield—Crop '02-'03
301	Davis'	Blue Stem	John A. Davis, Benton, N. D.	102	43	2¾	Velvety	59¼	1N	39.7	....
268	Aronautka	Macaroni	T. N. Oium, Lisbon, N. D	101	45	2¼	Sm Bearded	61	No. 1	43.4	36.0
269	Wild Goose	Macaroni	Wm. Rennie, Toronto, Canada	101	44	2¼	Sm. Bearded	61½	No. 1	44.0	35.1
270	Berdianska U. S. No. 1586	Macaroni	Russia by U. S. Dept. of Agr.	100	40	2	Sm. Bearded	62½	No. 1	40.6	34.6
271	Navowssick U. S. No. 1567	Macaroni	Russia by U. S. Dept. of Agr.	100	41	2	Sm. Bearded	62	No. 2	41.5	31.0
273	Argentine U. S. No. 1740	Macaroni	Marseilles. Fr., by U. S. Dep. Ag.	99	40	2	Sm. Bearded	63	No. 1	44.6	37.0
274	Tagenrog U. S. No. 1570	Macaroni	Tagenrog, Rus., by U. S. Dep. Ag.	100	39	2¼	Sm. Bearded	62¾	No. 1	46.7	39.2
276	Medeah U. S. No. 1371	Macaroni	Algeria, by U. S. Dept. of Agr.	96	42	2¼	Sm. Bearded	59½	No. 2	36.6	33.0
277	Yellow Gharnovka U. S. No. 1444	Macaroni	Ambrocievka, Rus., U. S. Dep. Ag.	98	42	2¼	Sm. Bearded	62½	No. 1	41.7	37.3
279	Black Don U. S. No. 1446	Macaroni	Ambroceivka, Rus., U. S. Dep. Ag.	98	40	2	Vel. Bearded	62½	No. 1	45.5	39.4
280	Gharnovka U. S. No. 1447	Macaroni	Tagenrog, Rus., by U. S. Dep. Ag.	99	39	2¼	Sm. Bearded	62¼	No. 1	46.5	38.4
281	Beloturka U. S. No. 1520	Macaroni	Russia by U. S. Dept. of Agr.	100	43	2¼	Sm. Bearded	59¾	No. 1	46.3	38.1
282	Kubanka U. S. No. 1440	Macaroni	Malsk Fer., Rus., U. S. Dep. Ag.	99	43	2	Sm. Bearded	62¾	No. 1	44.0	36.3
283	Velvet Don U. S. No. 1445	Macaroni	Ambroceivka, Rus., U. S. Dep. Ag.	99	42	2	Vel. Bearded	63	No. 1	42.6	37.6
302	Nicaragua U. S. No. 4277	Macaroni	U. S. Dept. of Agriculture	100	43	2¼	Sm. Bearded	64	No. 1	48.8	....
223	Kubanka U. S. No. 2953	Macaroni	Russia, by U. S. Dept. of Agr.	100	44	2¼	Sm. Bearded	62¾	No. 1	40.4	....
222	Pererodka U. S. No. 2954	Macaroni	Russia, by U. S. Dept. of Agr.	100	42	2	Sm. Bearded	62	No. 1	47.0	36.3
278	Gharnovka U. S. No. 1443	Macaroni	Ambroceivka, Rus., U. S. Dep. Ag.	100	40	2	Sm. Bearded	63	No. 2	44.5	35.1

In presenting the data in tabular form the varieties have been grouped into classes in accordance with their fife, blue stem and macaroni characteristics. It will be noted that the yields for 1903 were unusually high, although the average for the two seasons of 1902 and 1903 made a good showing. It will also be noted that the macaroni varieties gave better yields than either the fife or blue stem strains as groups. Summarizing the different classes of grain for 1903, and taking the average yield for the six best varieties of macaroni, fife and blue stem, the following tables result:

TABLE II.—VARIETIES OF WHEAT IN EACH CLASS GIVING LARGEST YIELDS IN 1903.

Bulletin No.	Variety	Class	Grade	Weight Per Bu.—Pounds	Yield Per Acre—Bushels
252	Selected McKendry's Minn. No. 181	Fife	1H	61½	44.5
290	North Dakota crossbred	Fife	1H	61¼	44.4
151	Glyndon No. 711	Fife	1N	58½	43.4
293	Selected Rystings Minn, No. 171	Fife	1N	57¼	42.3
295	Selected Powers	Fife	1H	60½	42.1
288	North Dakota crossbred	Fife	1H	60¾	41.6
287	Selected Haynes	Blue Stem	1N	56½	47.3
265	Bolton's Minn. No. 146	Blue Stem	1N	60	43.2
267	American	Blue Stem	1N	60	40.3
301	Davis'	Blue Stem	1N	59¼	39.7
264	Haynes' Minn. No. 51	Blue Stem	1N	60½	39.3
300	North Dakota crossbred	Blue Stem	1N	60½	39.1
302	Nicaragua	Macaroni	No. 1	64	48.8
222	Pererodka U. S. No. 2954	Macaroni	No. 1	62	47.0
274	Tagenrog U. S. No. 1570	Macaroni	No. 1	62¾	46.7
273	Argentine U. S. No. 1740	Macaroni	No. 1	63	44.6
280	Gharnovka U. S. No. 1447	Macaroni	No. 1	62¼	46.5
281	Beloturka U. S. No. 1440	Macaroni	No. 1	59¾	46.3

TABLE III.—COMPARING THE AVERAGE YIELD OF THE SIX BEST VARIETIES OF WHEAT IN EACH CLASS FOR 1903.

Class	Yield Per A.—Bu.	Difference—Bu.
Macaroni	46.65	....
Fife	43.17	3.48
Blue Stem	41.49	5.16
Blue Stem and Fife	42.33	4.32

From the above tables it will be seen that the six best macaroni varieties made an average yield of more than forty-six bushels of wheat per acre, while the six best fife strains produced more than forty-three bushels per acre. The blue stems yielded less than the fife varieties and failed to average as high in grade.

From the above tables it will be noted that the macaroni strains out-yielded the fife and blue stem varieties this year four and one-

third bushels per acre, which is quite in keeping with the results obtained during the previous four seasons of the trial. During the five years from 1899 to 1903 we have noted the yields from the three best varieties of macaroni wheat as compared with the three best fife and blue stem performing strains is four and two-tenths (4.2) bushels per acre, as is shown in Table IV.

TABLE IV.—COMPARING THE AVERAGE YIELD OF THE THREE BEST VARIETIES OF MACARONI WHEAT AGAINST FIFE AND BLUE STEM FOR FIVE YEARS.

Year	Macaroni	Fife & Blue Stem	Difference
1899	34.9	26.6	+8.3
1900	20.5	23.6	−3.1
1901	33.1	28.6	+4.5
1902	32.6	24.9	+7.7
1903	47.5	43.8	+3.7
Average for five years	33.7	29.5	+4.2

The range by years is from three and one-tenth (3.1) bushels less for the macaroni wheat in the season of 1900 to eight and three tenths (8.3) bushels greater yield in the season of 1899. The results presented in this tabular statement constitute a strong indorsement of the yielding capacity of macaroni wheat.

Summarizing the results obtained from the five best yielding varieties of fife, blue stem and macaroni wheat for the seasons of 1902 and 1903, we have the following tabular statement of facts:

TABLE V.—VARIETIES OF WHEAT IN EACH CLASS GIVING THE LARGEST AVERAGE YIELD IN 1902-1903.

Bulletin No.	Variety	Class	Grade		Weight Per Bu.—Pounds		Average Yield Per Acre—Bushels
			1902	1903	1902	1903	
290	North Dakota crossbred	Fife	2N	1H	59¼	61¼	34.9
257	Selected Minn. No. 285	Fife	1N	1H	60½	61½	34.4
252	Selected McKendry's Minn. No. 181	Fife	1N	1H	60¼	61½	34.2
258	Selected Minn. No. 288	Fife	1N	1H	61	61½	33.3
236	Wellman's	Fife	1N	1H	59¾	60	32.5
287	Selected Haynes	Blue Stem	2N	1N	59½	56½	35.5
262	Haynes' Pedigreed	Blue Stem	1N	1N	59¾	60	30.4
265	Bolton's Minn. No. 146	Blue Stem	2N	1N	57¾	60	30.3
264	Haynes' Minn. No. 51	Blue Stem	2N	1N	58½	60½	30.2
267	American	Blue Stem	2N	1N	57	60	29.9
279	Black Don	Macaroni	no gr.	No. 1	63	62½	39.4
274	Tagenrog U. S. No. 1570	Macaroni	No. 2	No. 1	63¾	62¾	39.2
280	Gharnovka U. S. No. 1447	Macaroni	No. 1	No. 1	63½	62¼	38.4
281	Beloturka U. S. No. 1520	Macaroni	No. 1	No. 1	63	59¾	38.1
283	Velvet Don U. S. No. 1445	Macaroni	No. 2	No. 1	64½	63	37.6

The greater the number of years which may be summarized into a record the larger the degree of importance which can be placed upon the evidence. The table has the additional feature of giving the grades which the wheat was awarded.

Summarizing the results for three years for the five best varieties in the three different classes, we have the following tabular statement of the yield and grade, which is in an easy form for reference:

TABLE VI—VARIETIES OF WHEAT IN EACH CLASS GIVING THE LARGEST AVERAGE YIELD FOR THREE YEARS.

Bulletin No.	Variety	Class	Grade			Weight Per Bushel—Pounds			Average Yield Per Acre
			1901	1902	1903	1901	1902	1903	
257	Selected Minn. No. 285	Fife	2N	1N	1H	60	60½	61½	32.2
252	Selected McKendry's Minn. No. 181	Fife	2N	1N	1H	58½	60¼	61½	31.9
258	Selected Minn. No. 288	Fife	2N	1N	1H	58	61	61½	30.2
260	Selected Minn. No. 293	Fife	2N	2N	1H	58½	60	60½	29.8
254	Pillsbury	Fife	3N	1N	1N	58	60½	59½	29.6
267	American	Blue Stem	2N	2N	1N	59	57	60	30.2
265	Bolton's Minn. No. 146	Blue Stem	2N	2N	1N	59	57¾	60	30.1
264	Haynes' Minn. No. 51	Blue Stem	2N	2N	1N	59¼	58½	60½	3 .0
262	Haynes' Pedigreed	Blue Stem	2N	1N	1N	58	59¾	60	29.6
263	Marvel	Blue Stem	2N	1N	1N	58	58½	60	29.1
280	Gharnovka U. S. No. 1447	Macaroni	No. 2	No. 1	No 1	61	63½	62¼	36.3
281	Beloturka U. S. No. 1520	Macaroni	No. 2	No. 1	No. 1	62	63	59¾	36.3
274	Tagenrog U. S. No. 1570	Macaroni	No. 3	No. 2	No. 1	58½	63¾	62¾	36.1
268	Aronatka	Macaroni	No. 2	No. 2	No 1	62	62	61	35.4
277	Yellow Gharnovka U. S. No. 1444	Macaroni	No. 2	No. 2	No. 1	61¾	63	62¼	35.2

It is also interesting to note that a large portion of the better yielding strains are from the North Dakota and Minnesota Experiment Station bred varieties. All of the strains listed as selected or cross bred (with the single exception of Preston, a cross bred strain brought out by Dr. Saunders of the Central Experiment Station of Canada) are from either one or the other of these stations. Those who have followed the successful varieties during the last ten years have seen the names of North Dakota farmers in connection with the variety names of the most successful strains, which means that the Station has either improved the varieties secured from its wheat growing neighbors, or that the Station has not been able to collect or breed seeds which are superior to those that the wheat growers of this state have bred up.

As a means of presenting the data secured, in a comprehensive form, a detailed yearly report is made in the following table, which gives the yields that were obtained from varieties that were grown three or more seasons during the last thirteen years:

TABLE VII.—VARIETIES OF WHEAT, GIVING YIELDS PER ACRE FOR THE YEARS GROWN.

Bulletin No.	Variety	Yield Per Acre—Bushels												Av. Yield Per Acre
		1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	
66	Powėr's Fife	21.33	15.10	12.67	41.25	19.65	10.67	34.66	24.69	18.83	*(261) 26.99	(261) 23.10	(261) 38.52	23.96
23	Red Fife	14.33	12.00	11.07	48.00	25.60	8.67	32.00	25.01	26.39	26.15	22.80	......	22.91
50	Wellman's Fife	23.00	12.20	......	42.00	......	11.67	34.33	24.32	27.97	27.93	21.30	*(236) 42.31	26.70
120	Glyndon (774) Fife	17.33	12.60	11.07	48.33	20.67	8.33	32.96	23.23	......	......	......	......	21.81
146	Bolton's Blue Stem	......	17.80	12.27	42.00	......	10.00	36.43	26.55	25.62	*(265) 29.67	(265) 17.50	(263) 43.20	26.10
148	C. & C. Land Co.'s Fife	......	......	11.20	42.00	......	11.83	36.19	23.62	......	......	......	......	24.97
151	Glyndon (711) Fife	......	......	......	......	......	8.50	35.60	24.78	25.50	......	24.00	43.36	26.96
197	Preston Crossbred	......	......	......	......	......	11.83	37.88	27.62	10.37	24.89	25.00	38.76	25.15
215	Rystings' Fife, Minn. No. 171	......	......	......	......	......	......	38.12	26.63	20.02	......	†(293) 27.10	(293) 42.31	30.84
216	Selected McKendry's Fife, Minn. No. 181	......	......	......	......	......	......	35.45	24.56	21.72	**(252) 27.15	(252) 24.00	(250) 44.49	29.56
212	Glyndon (811), Minn. No. 163	......	......	......	......	......	......	37.23	25.86	22.95	......	......	......	28.68
210	Select Glyndon (818), Minn. No. 155	......	......	......	......	......	......	......	23.63	20.76	**(250) 25.30	(250) 24.10	(250) 37.86	26.33
253	Saskatchewan Fife	......	......	......	......	......	......	......	......	......	27.18	24.10	34.38	28.55
257	Selected Minn. No. 285	......	......	......	......	......	......	......	......	......	29.93	25.30	41.34	32.19
258	Selected Minn. No. 288	......	......	......	......	......	......	......	......	......	24.93	25.80	40.78	30.50
262	Haynes' Pedigreed Blue Stem	......	......	......	......	......	......	......	......	......	28.13	21.20	36.74	28.69
263	Marvel	......	......	......	......	......	......	......	......	......	28.37	24.10	37.71	30.06
264	Haynes' Minn. No. 51	......	......	......	......	......	......	......	......	......	29.67	21.20	39.32	30.06
267	American Blue Stem	......	......	......	......	......	......	......	......	......	30.47	18.10	40.29	29.62
268	Aronautka (Macaroni)	......	......	......	......	......	......	......	......	20.58	34.01	28.70	43.44	31.68
222	Pererodka (Macaroni)	......	......	......	......	......	......	......	34.87	17.13	34.68	25.70	47.00	31.88
274	Tagenrog (Macaroni)	......	......	......	......	......	......	......	......	......	29.75	31.70	46.75	36.07
223	Kubanka (Macaroni)	......	......	......	......	......	......	......	30.05	......	*(283) 32.46	(283) 28.70	(283) 44.01	35.06
280	Gharnovka (Macaroni)	......	......	......	......	......	......	......	......	......	32.40	30.30	46.51	36.40
283	Velvet Don (Macaroni)	......	......	......	......	......	......	......	......	......	29.62	32.50	42.63	34.92
281	Beloturka (Macaroni)	......	......	......	......	......	......	......	......	......	32.61	29.90	46.35	36.29

* Original seed from this station.
** Seed renewed from other stations.
† Selected seed from original bulletin numbers.
The small figures enclosed in parentheses are the bulletin numbers now published under,

It will be noticed that record numbers have been changed in some instances. This was necessary because the strains have been somewhat changed. Some of them have taken a vacation at the Minnesota Station for a season or more, and others have been changed by breeding and selection, into forms different enough to be worthy of separate consideration. The missing years are usually the result of some mishap in the field or elsewhere.

The destruction of the College barn in 1901 caused the entire loss of some of the better strains of grain which were in the possession of the Station at that time, and resulted in our collecting them by securing seed from other Stations to whom seed had been given at previous dates. The vast amount of data and of work and the expenditure of funds which is represented by this extensive trial have as their chief object the selection and positive identification of the better strains of grain which the Station is making and placing in the hands of North Dakota grain growers.

A FERTILIZER TRIAL WITH WHEAT.

During the season of 1903 the first comprehensive trial with different fertilizers for grain was begun at this Station. The land selected for the trial had produced a great number of crops of wheat and was what would be called old land. It had been sown to barley the previous season and produced a crop of flax in 1901. Prior to that time the land had been in timothy for a few years. The land had never been enriched by the application of stable manure, and in consequence represented fairly well the older fields of North Dakota which had been cropped constantly to small grain. Different kinds of fertilizers were applied to six plots of ground, and these plots were compared with a seventh which received no fertilizer. The grade, weight per bushel and the percentage of lodged grain were recorded in addition to the yield per acre. The data is presented in a rather comprehensive way in the following tabular statment:

TABLE VIII.—FERTILIZER EXPERIMENTS WITH WHEAT CROP OF 1903.

Plot No.	Name of Fertilizer	Grade	Weight Per Bu.—Lbs.	Yield Per A.—Bushels	Per Cent Lodged
1	Acidulated Bone	1N	59¾	30.4	10
2	Amour's Grain Grower	1N	59½	33.2	5
3	Ammoniated Bone and Potash	1N	60¼	32.2	20
4	All Soluble	1N	60	31.9	8
5	Nitrate of soda	1N	59½	33.0	10
6	Rotted manure	2N	60	29.5	10
7	No fertilizer	1N	60	25.7	3

From the above table it will be seen that the yield from the plot of grain which received no fertilizer whatever was seven and one-

half bushels less than was secured from the fertilizer, Amour's Grain Grower, which gave the heaviest yield per acre. It will also be noted that the plot which was treated with well rotted stable manure, at the rate of ten loads per acre, ranked below those which had been treated with 200 pounds of commercial fertilizer per acre. An interesting fact may be noted in the column which gives the percentage of lodged grain. An inspection of the table will show that the plot receiving no fertilizer was lodged the least and the one with the highest yield was second, while one-fifth of the grain on the Ammoniated Bone and Potash plot was lodged. The indication from that portion of the trial is that grain growers should be on their guard for fear that a heavy application of fertilizer would bring about a severe loss by causing an undue amount of the grain to lodge.

VARIETIES OF WINTER WHEAT.

A few of the seasons prior to that of 1903 gave encouraging results from trials in growing winter wheat on the Station grounds. The plan of the experiment was to allow the winter to destroy all that it would, thus leaving only hardy and vigorous plants with which to continue the trial. Three varieties of winter wheat were used in the trial, one of which sprang from the surviving plants produced annually since 1900, while the others were descended from grain which was first grown upon the Station trial grounds in 1901. The trial was made on a piece of ground which was divided into strips or plots extending from a shelter belt of trees out upon the open field. The wheat plants killed out completely during the winter of 1902-1903 except near the shelter belt, where they were covered with snow. In the sheltered place near the belt of trees mentioned above the stand of grain was very good and produced a heavy yielding patch of wheat, but the exposed portion proved disappointing by failing to have a single plant survive. The grain produced was of good quality, showing a plump and bright berry. The trials thus far carried on by the Station with winter wheat have given results which indicate that it is impractical for North Dakota producers to attempt to grow it.

VARIETIES OF WINTER RYE.

Small plots of winter rye were sown on September 23, 1903, in order that a study might be made of the climatic effect which this northern latitude would have upon the crop, as well as to determine the success of winter rye as a crop for this state.

The land used for the trial was timothy sod which had been broken in May, 1901, and a little later in the season of that year a number of varieties of grasses were seeded upon it and failed to make a stand. They were plowed up on July 9th to a depth of five inches, after which the ground was harrowed several times at various intervals

before the date of seeding the grain, when it was harrowed twice with a peg-tooth drag. The land was in good condition when the grain was seeded, and the crop sprang up quickly and made a good stand by the 9th of September. On April 13th, the following spring, the winter rye was making a good showing. The following table gives the results of the trial in detail:

Bulletin No.	Variety	Date Sown	Date Harvested	Length of Straw-In.	Length of Heads-In.	Yield Per Acre-Bu.
953	Giant	Sept. 3	July 14	46	4½	8.12
959	Home grown	Sept. 3	July 7	49	3¼	33.13
964	N. K. & Co	Sept. 3	July 7	50	4	25.70
1134	N. K. & Co., best	Sept. 3	July 7	51	3½	33.02

The variety numbered 959 was a sample which sprung up in a piece of winter wheat in 1902. There was only a small intermixture of the rye, but as it withstood the winter well while the winter wheat which surrounded it was destroyed, the seed of it was saved with the hope that a hardy strain might be developed.

Sample 964 was purchased from Northrup, King & Co., seedmen, in the fall of 1901, and the first crop was harvested the following summer. The variety 1134, which was produced from seed purchaser from Northrup, King & Co. just before the date of seeding, was what they called their best strain of fall rye. The strain of seed listed 953 was secured from an Ontario seed firm in 1901 and was sown on the trial grounds at the Station in the fall of 1901. It will be seen that the Ontario sample made a very poor yield and has little value for this district of country. The home grown sample which came from the fall wheat intermixture and the one recently secured from Northrup, King & Co. gave reasonably good results. It will be noted also that their dates of harvesting are early enough to permit of their being placed in the shock before other kinds of small grain will require the attention of the grower.

VARIETIES OF OATS.

Twenty-nine strains of oats were planted in the variety trial for 1903. A few of them were recent importations by the United States Department of Agriculture, a number have been secured from the seed firms of the country, while a few are new strains which have been bred up by the North Dakota and Minnesota Experiment Stations. The object of the trial with oats has been to produce varieties of greater value than the strains that are now in the hands of North Dakota oat growers. The misfortune of losing the Station stock

of seed of a few good strains in 1901, when the College barn and seed house was destroyed by fire, has kept the institution from offering superior kinds of oats at earlier dates.

The object of the variety trial is largely to determine which of the varieties improved by breeding and selection in the plant nursery will prove superior when produced upon a field scale. The Station takes pains to collect the seed of varieties which the seedmen and plant breeders of other Stations report as promising for the conditions which prevail in this state.

Three very early oats have been secured, one of which has given excellent yields during the past few years. It was unfortunate during the season of 1903, however, in having its grain forming period fall during the time when a drouth was prevalent in this section of the state.

TABLE IX.—VARIETIES

Bulletin No.	Variety	Where From	Days Maturing	Length of Straw—Inches	Form of Head
110	U. S. No. 5168	U. S. Dept. of Agriculture	79	29	Whorled
84	Sixty Day U. S. No. 5938	Russia by U. S. Dept. of Agricul.	80	28	Whorled
121	English	Wm. Lanxon, Forman, N. D.	84	28½	Whorled
111	Czar of Russia	H. Hammond, Fifield, Mich.	92	36	Whorled
112	North Finland U. S. No. 5139.	Koivikko, Fin., by U. S. Dpt. of A.	92	34½	Whorled
103	Ligowa	Wm. Rennie, Toronto, Can.	92	32	Whorled
104	New Zealand	Wm. Rennie, Toronto, Can.	92	30	Side
120	Swedish Select U. S. No. 9422	Russia by U. S. Dept. of Agri.	92	34	Whorled
87	Big Four	J. A. Salzer Seed Co.	92	35	Whorled
89	Bow of Promise	J. A. Salzer Seed Co.	92	33	Whorled
46	Selected Black Beauty	North Dakota Exp. Station	92	32	Whorled
119	Twentieth Century	Salzer Seed Co.	92	32	Whorled
48	Zhelarmii U. S. No. 2963	Russia by U. S. Dept. of Agri.	92	36	Whorled
118	Scottish Chief	L. L. May & Co.	92	32	Whorled
100	Siberian White	Wm. Rennie. Toronto, Can.	93	36	Whorled
2	Archangel	College Farm	93	38	Whorled
42	U. S. No. 3	Russia by U. S. Dept. of Agri.	93	35	Whorled
50	Tobolsk U. S. No. 2800	Russia by U. S. Dept. of Agri.	93	38½	Whorled
98	Minn. No. 202	Minnesota Experiment Station	94	34	Whorled
102	Abundance	Wm. Rennie, Toronto, Can.	94	35	Whorled
105	New Danish White	Wm. Rennie, Toronto, Can.	94	32	Whorled
115	White Waverly	Wm. Rennie, Toronto, Can.	94	36	Whorled
116	Golden Cluster	L. L. May & Co.	94	30	Whorled
93	Lincoln	O. H. Will & Co., Bismarck, N. D.	94	36	Whorled
94	Early Gothland Minn. No. 26.	Minnesota Experiment Station	95	35½	Whorled
39	White Russian	Minnesota Experiment Station	99	36	Side
54	Selected Tartarian	North Dakota Exp. Station	99	36	Side
122	Selected Great Northern	J. A. Salzer Seed Co.	99	33	Side
64	Negro Wonder	Farmer's Seed Co.	102	38	Whorled

OF OATS—CROP OF 1903.

Length of Heads—Inches	Lodged—Per Cent	Rust—Per Cent	Color of Berry	Size of Berry	Shape of Berry	Weight Per Bu.—Pounds	Yield Per Acre—Bushels	Average Yield for 1902-1903
5½	0	0	Yellow	Small............	Slender..............	35	50.7	....
5	0	0	Yellow	Small............	Slender..............	34¾	*42.0	57.1
5½	0	0	White...........	Small............	Short plump........	39¼	41.6	....
6½	0	15	White...........	Medium large...	Short plump........	37½	66.1	50.3
7	0	8	Black...........	Medium	Slender..............	32¾	51.8	34.6
6	0	20	White...........	Large............	Short plump........	39¾	61.6	50.1
6½	0	8	White...........	Medium large...	Medium long........	38¼	66.3	57.8
5½	0	20	White...........	Large............	Short plump	40	68.2	....
7½	0	20	White...........	Large............	Medium long........	40	70.5	56.1
6½	0	15	Light yellow....	Medium large...	Medium long........	35¾	63.4	50.0
6½	0	20	Black...........	Small............	Slender..............	36¾	68.5	56.4
6	0	15	White...........	Medium large...	Plump................	40	59.9	50.8
8	0	15	White...........	Medium large...	Medium long plump	39¾	61.7	48.9
6	0	15	White...........	Large............	Medium long plump	38¾	61.6	51.2
7½	0	25	White...........	Medium large...	Long..................	37½	69.1	58.1
8½	0	20	White...........	Medium..........	Short plump........	37½	66.9	50.5
7½	0	10	White...........	Medium..........	Short plump........	39½	59.5	50.6
7	0	15	White...........	Medium..........	Short plump........	39½	69.9	53.4
7½	0	10	Light yellow....	Medium..........	Medium long........	38½	57.4	49.8
7	0	25	White...........	Medium large...	Long plump..........	36	71.2	59.3
6	0	20	White...........	Medium..........	Short plump........	37¾	62.0	....
7	0	25	White...........	Large............	Long plump..........	37¾	73.8	58.1
6	0	20	Yellow	Large............	Long plump..........	35¾	61.0	49.9
7	0	10	White...........	Medium large...	Medium long........	36½	66.1	50.0
7½	0	20	White...........	Medium..........	Medium long........	36½	56.5	46.4
8½	0	2	White...........	Large............	Medium long........	39¾	74.9	65.3
8	0	2	White...........	Medium..........	Medium long........	39	77.3	70.6
8	0	5	White...........	Medium large...	Medium long........	39	69.6	....
9	0	20	Black...........	Large............	Medium long........	35¼	58.6	39.2

* Shelled out badly by sparrows.

The oat varieties were planted upon the wheat ground of 1902 that had been fall plowed and handled so that it was in good condition for a crop. The land had produced a crop of corn in 1901, the effect of which was probably still present to a considerable extent. The ground was harrowed twice, or cross harrowed, on April 22d and 23d, and the grain was sown on the dates of May 4th and 5th. The seed of the oats was treated for smut by the formaldehyde treatment before it was put into the trial. The grain came up promptly, and with the exception of an early strain, which suffered severely from a dry spell of weather during the latter part of June, it did very well, as will be seen by the accompanying table. The grain was threshed on the first day of September, 1903.

The following table gives the fourteen highest yielding varieties grown in the trial for 1903:

TABLE X.—VARIETIES OF OATS GIVING LARGEST YIELD IN 1903.

Bulletin No.	Variety	Days Maturing	Weight Per Bu.—Lbs.	Yield Per A.—Bushels
111	Czar of Russia	92	37½	66.1
104	New Zealand	92	38¼	66.3
120	Swedish Select U. S. No. 9422	92	40	68.2
46	Selected Black Beauty	92	36¾	68.5
87	Big Four	92	40	70.5
2	Archangel	93	37½	66.9
100	Siberian White	93	37½	69.1
50	Tobolsk U. S. No. 2800	93	39½	69.9
102	Abundance	94	36	71.3
115	White Waverly	94	37¾	73.8
93	Lincoln	94	36½	66.1
39	White Russian	99	39¾	74.9
54	Selected Tartarian	99	39	77.3
122	Selected Great Northern	99	39	69.6

The table indicates that there was a decided advantage secured by having a later ripening and filling period during the past season.

Another tabular statement of results is presented herewith which gives the highest average yields for the seasons of 1902-1903, from which it will be seen that a different list of varieties has taken an advanced place, and that the honors are divided somewhat between the early and late strains.

TABLE XI.—VARIETIES OF OATS GIVING LARGEST AVERAGE YIELD FOR 1902-1903.

Bulletin No.	Variety	Average Days Maturing	Av. Weight Per Bu.—Pounds	Av. Yield Per Acre—Bushels
84	Sixty Day U. S. No. 5938	77	34.4	57.1
46	Selected Black Beauty	87	32.0	56.4
87	Big Four	88	32.4	56.1
100	Siberian White	89	34.1	58.1
102	Abundance	90	29.6	59.3
115	White Waverly	90	30 9	58.1
104	New Zealand	94	35.8	57.8
39	White Russian	97	36.4	65.3
54	Selected Tartarian	97	36.1	70.6

It may be noted, however, by consulting both of the tabular reports, that No. 54, which came from the Station plant breeding nursery, gave the highest average yield for both seasons, and that it was the highest yielding strain in the season of 1903. It is a very promising variety, and will be distributed by sale as soon as the quantity in stock can be increased sufficiently to permit the following out of that plan.

The following table summarizes the entire results of the trial made by the Station with the varieties of oats during the twelve years, and forms an interesting study for those who wish to follow it.

TABLE XII.—VARIETIES OF OATS, GIVING YIELDS FOR THE NUMBER OF YEARS GROWN.

Bulletin No.	Variety	Yield Per Acre—Bushels											Av. Yield —Bu.
		1892	1893	1894	1895	1897	1898	1899	1900	1901	1902	1903	
2	Archangel	68.00	33.10	54.50	38.00	64.10	70.82	69.12	23.88	*(108) 42.51	34.10	66.90	51.37
26	Tartarian	......	31.20	62.25	53.33	54.10	74.87	64.96	34.85	*(83) 43.91	**(54) 63.90	**(54) 77.27	56 06
19	Black Beauty	......	27.20	66.75	50.67	45.30	65.47	73.89	**(46) 15.37	* 37.21	**(46) 44.30	**(46) 68.50	49.47
12	Race Horse	......	40.40	62.75	41.50	47.50	74.87	64.96	33.55	*(81) 43.25	*(81) 49.30	......	50.87
29	Giant Yellow	......	11.50	30 00	50.33	41.90	74.44	61.32	......	......	......	......	44.92
39	White Russian	......	......	59.75	38.75	37.20	70.38	65.87	38.59	......	55.80	74.90	55.15
40	Lincoln	......	......	52.50	40.00	53.50	68.86	67.91	26.78	***(93) 57.48	***(93) 33.90	***(93) 66.10	51.87
35	American White Banner	......	......	54.00	47.33	58.50	72.41	74.27	25.92	*(82) 55.18	*(82) 33.50	......	52.64
37	Great Northern	......	......	58.50	42.00	47.50	75.81	69.27	**(53) 24.63	***(88) 56.02	***(88) 38.05	......	51.47
36	Early Gotham	......	......	59.38	31.33	47.00	75.08	73.13	......	......	......	......	57.18
38	North Star	......	......	32.50	45.00	48.50	70 38	77.67	......	......	......	......	54.81
41	Lee	......	......	......	......	34.60	52.66	57 70	34.56	......	......	......	44.88
42	U. S. No. 3	......	......	......	......	......	71.47	72.00	25.56	......	41.80	59.50	54.07
45	Silver Mine	......	......	......	......	......	......	81.08	23.23	***(85) 60.93	***(85) 39.20	***(85) 72.99	55.49
48	Zhelarmii	......	......	......	......	......	......	79 89	21.99	......	36.20	61.70	49.95
50	Tobolsk	......	......	......	......	......	......	70.64	21.88	......	36.90	69.90	49.83
51	Swedish Select	......	......	......	......	......	......	75.40	23.04	......	30.80	68.22	49.37
84	Sixty Day	......	......	......	......	......	......	......	......	50.44	72.20	**** 41.96	54.87
98	Minn. No. 202	......	......	......	......	......	......	......	......	67.10	48.20	57.37	57.56
87	Big Four	......	......	......	......	......	......	......	......	58.80	41 60	70.50	56.97
100	Siberian White	......	......	......	......	......	......	......	......	60.50	47 00	69.12	58.87
102	Abundance	......	......	......	......	......	......	......	......	58.95	47.50	71.24	59.23
103	Ligowa	......	......	......	......	......	......	......	......	58.36	38.60	61.58	52.85

* Seed from Missouri but original seed from this station.
** Seeds are selections from original seed.
*** From seed firms in 1901.
The figures in parentheses are the bulletin numbers as they are published.
**** Partially destroyed by birds.

The selection of a variety of oats which will resist the attack of rust is one of the more important features of oat breeding in the plant nursery.

The record numbers of some of the varieties of oats listed in the above tables have been changed in a way which was described for the wheat varieties listed in Table VI.

VARIETIES OF BARLEY.

Eighteen varieties of barley were sown in the trial for 1903. The seed was treated with formaldehyde in the ordinary way and the ground was prepared in the manner already described for the oat variety land. The varieties of barley were planted on May 5th and 6th at a depth of two inches. The soil was in good condition, and on May 16th the barley was up and making a nice showing.

TABLE XIII.—VARIETIES OF BARLEY—CROP OF 1903.

Bulletin No.	Variety	Where From	Days Maturing	Length of Straw—In.	Length of Head—In.	No. Rows Per Head	Length of Beard—In.	Lodged—Per Cent	Grain: Size of Berry	Grain: Color of Berry	Grain: Weight Per Bu. —Pounds	Grain: Yield Per Acre —Bushels	Average Yield for 1902–1903
58	Seneco's Purple	L. F. Seneco, Fargo, N. D.	76	28	1¾	6	4½	0	Large..	Bluish..	58½	36.6	....
51	Minnesota No. 100	Minnesota Experiment Station	77	34	2¼	6	4	2	Medium	Lt. Yel.	50½	40.7	50.1
56	Common Six-rowed	E. G. Schollander, Montpelier, N.D.	78	35	2¼	6	5	0	Medium	Lt. Yel.	49½	40.3	49.0
45	Great Beardless	John A. Salzer Seed Co.	74	40	2¼	6	...	0	Small ..	Lt Yel.	43	34.9	42.1
21	McEwan's Hulless	Park River, N. D.	79	27	3¼	2	6	75	Large...	Amber..	57½	35.5	41.8
49	Barnard's Minn. No. 28	Minnesota Experiment Station	79	34	1¾	6	5	0	Medium	Lt. Yel.	50	38.1	47 2
55	Manscheuri	Wm. Rennie, Toronto, Canada	79	36½	2¼	6	4½	0	Medium	Lt. Yel.	48	39.4	47.6
22	Russian U. S. No. 5	U. S. Dept. of Agriculture	79	35	2¾	6	5	0	Medium	Lt. Yel,	47¾	39.1	....
44	Silver King	John A. Salzer Seed Co.	80	34	2½	6	6	0	Medium	Lt. Yel.	48½	40.7	48.0
47	Mansury's Minn. No. 6	Minnesota Experiment Station	80	36	2	6	5	0	Medium	Lt. Yel.	48	44.5	49.9
48	Minnesota No. 32	Minnesota Experiment Station	80	36	2¼	6	4½	0	Medium	Lt. Yel.	48½	40.4	47.1
50	Minnesota No. 87	Minnesota Experiment Station	80	34½	2	6	4	0	Medium	Lt. Yel.	48	36.8	45.8
52	Minnesota No. 105	Minnesota Experiment Station	80	35	2¼	6	4	0	Medium	Lt. Yel.	48¼	39.2	45.8
25	Mansury's Minn. No. 6	Minnesota Experiment Station	80	36	2¼	6	5	0	Medium	Lt. Yel.	47¼	37.1	46.8
7	Two-rowed Mausury	N. B. A. G. Co.	82	34	2¾	2	6	0	Med. l'ge	Lt. Yel.	47	33.0	45.1
43	Moravian U. S. No. 5793	Hungary by U. S. Dept. of Agri.	82	31	2¾	2	6	10	Medium	Lt. Yel.	51	40.2	44.6
19	Success	Minnesota Experiment Station	91	25	3	2	5½	3	Large...	Lt. Yel.	51½	45.3	45.9
53	Highland Chief	Northrop, King & Co.	91	27	3	2	5	2	Large...	Lt. Yel.	50¾	42.7	43.9

The varieties of barley were sown upon ground which was used for a trial of thick and thin planted corn during the season of 1902. The barley was more or less irregular in growth as measured by the height and thriftiness in different portions of the plots, being short in straw and head on the thick planted corn ground of 1902, and of good height and bearing good heads where the ground grew corn in rows the previous year. Wild rose bushes were thick on the strips which had grown sowed corn, while the adjoining pieces which had produced corn in rows and had been cultivated the previous season were almost free from that weed pest. The barley varieties showed very noticeable indications of suffering from dry weather the latter part of June. The harvesting of varieties of barley was begun on July 21st, and all of the kinds were threshed on September 11, 1903.

As a matter of summarizing the results for easy reference, the eight best yielding sorts are grouped together in the following table:

TABLE XIV.—VARIETIES OF BARLEY GIVING LARGEST YIELD IN 1903.

Bulletin No.	Variety	Days Maturing	Weight Per Bu. —Pounds	Yield Per Acre —Bushels
51	Minnesota No. 100	77	50½	40.7
56	Common Six-rowed	78	49½	40.3
44	Silver King	80	48½	40.7
47	Mansury Minnesota No. 6	80	48	44.5
48	Minnesota No. 32	80	48½	40.9
43	Moravian U. S. No. 5793	82	51	40.6
19	Success	91	51½	45.3
53	Highland Chief	91	50¾	42.7

For the sake of more extended data, a comparison of the eight highest yielding strains for the seasons of 1902-1903 are given in the following compiled form:

TABLE XV.—VARIETIES OF BARLEY GIVING LARGEST AVERAGE YIELD FOR 1902-1903.

Bulletin No.	Variety	Average Days Maturing	Av. Weight Per Bu.-Pounds	Av. Yield Per A. —Bushels
51	Minnesota No. 100	74½	50.3	50.1
56	Common Six-rowed	75½	47.5	49.0
49	Barnard's Minnesota No. 28	75½	49.3	47.2
55	Manscheuri	76	47.8	47.6
44	Silver King	77	48.3	48.0
47	Mansury's Minnesota No. 6	77	48.0	49.9
48	Minnesota No. 32	77	48.3	47.1
25	Mansury's Minnesota No. 6	77½	48.0	46.8

The strains of barley of the North Dakota Experiment Station breeding were not increased to sufficient quantity for a trial in the variety comparison during the past season. It is interesting to note, however, that the strains of Minnesota Station breeding take a prominent place in the list of best yielding strains as measured by the average yield for the two seasons of 1902-1903. It is also interesting to note that the Manscheuri strain which the Wisconsin Station disseminated several years ago still holds a prominent place among the heavier yielding varieties.

VARIETIES OF EMMER OR SPELT.

A trial with two varieties of emmer or spelt was made in 1903, the results from which are given in the following tabular form:

No.	Variety	Days Maturing	Weight Per Bu. —Lbs.	Yield Per A. —Bu.
2	North Dakota	95	38	*54.44
5	U. S. Dept. Agriculture	95	40	52.01

*Forty pounds per bushel.

The trial resulted in much the same comparative yield as was secured heretofore in similar experiments, the sample given the name of North Dakota showing a greater yield than the one supplied to the Station by the United States Department of Agriculture.

The following summarized statement of the yield of emmer or spelt for the seasons of 1902-1903 shows nearly the same proportionate difference in yields:

No.	Variety	Days Maturing	Weight Per Bu. —Lbs.	Yield Per A. —Bu.
2	North Dakota	94.5	37.5	53.77
5	U. S. Dept. Agriculture	95.5	37	50.91

The result of the trial seems to indicate that the effect of the environment of North Dakota has been to stimulate the yield from seed which has been grown under North Dakota conditions. It is interesting to note that in all such trials the questions of whether the result attributed to environment is an effect produced upon the plant as it grows, or whether it is a selective influence on the part of the climate which throws out the weaker and poorer plants and causes a variety to become a hardier and better yielding strain on that account.

Emmer or spelt is usually compared with barley and oats as an economic grain producer on North Dakota farms. The following table giving the results of six seasons' trial with emmer or spelt, barley, oats and wheat show how they compare in the pounds of grain which they produce per acre on the trial grounds at Fargo:

SHOWING COMPARATIVE YIELDS OF EMMER, BARLEY, OATS AND WHEAT FOR SIX SEASONS.

Kinds of Grain	1898 Lbs.	1899 Lbs.	1900 Lbs.	1901 Lbs	1902 Lbs.	1903 Lbs.	Av. Lbs.
Emmer............	2,338	2,291	980	2,518	2,469	2,101	2,116
Barley................................	2,326	2,360	844	1,946	2,780	2,079	2.056
Oats.........	2,400	2,436	1,058	1,933	1,988	2,378	2,032
Wheat..................................	2,212	1,552	1,379	1,719	1,590	2,694	1,861
Macaroni wheat.......................	......	1,948	1,167	1,997	1,943	2,833	1.978

From the above statement it will be seen that emmer or spelt is the stronger yielding crop on the average, although barley is a close competitor and during several seasons proved superior by giving greater yields. The results for the year 1900 indicate that occasionally the yield may be small on account of peculiar seasons. The trials at the Edgeley Sub-Station and the results reported by farmers from different districts outside of the Red River valley indicate that emmer or spelt is much more of a drouth resisting plant than barley and will prove much safer as a feed producing grain in the drier sections of the state. In the Annual Report bearing the date of February 1, 1902, the results of an analysis of emmer or spelt are given together with other trials showing the composition,

proportion of husk to kernel and other points in which it resembles or differs from oats or barley. Subsequent feeding trials made by this Station, and the experience of practical feeders, both indicate that the earlier statement concerning its feeding value was conservative rather than extravagant.

VARIETIES OF FLAX.

Nine varieties of flax were planted as a variety trial in 1903. They were sown at the uniform rate of two pecks per acre at a depth of one and one-half inches, which placed the seed about at the surface of the moist earth. With the exception of No. 16 they were all treated for the wilt disease by the formaldehyde treatment. Four other samples were sown, but as the quantity of seed was so limited as to make it necessary to put them in a small plot, the yields are incomparable with those of the uniform one-tenth acre plots. They were all seeded on the 14th of May, 1903, in uniform plots of ground lying side by side, with eighteen-inch alleyways between the varieties. The seed started growth promptly, as is shown by the fact that our records state that all of the varieties were up and making a good showing on June 22d.

TABLE XVI.—VARIETIES OF FLAX—CROP OF 1903.

Bulletin No.	Variety	Class	Where From	Date Sown	Seed Sown Per Acre—Pecks	Days Maturing	Length of Straw—Inches	Weight per Bushel—Pounds	Yield per Acre—Bushels	Average Yield for 1902-1903
7	Russian	Seed	John A. Salzer Seed Co.	May 14	2	92	19½	54½	16.1	20.9
9	Selected Russian	Seed	Selected No. 7 N. D. Exp. Station	May 14	2	92	20	54½	16.4	20.3
10	Selected Russian	Seed	Selected No. 7 N. D. Exp. Station	May 14	2	92	20	54¾	16.2	21.1
11	Argentine	Seed	C. Hendrickson, Grafton, N. D.	May 14	2	103	16	52½	15.9	19.2
12	Siberian	Seed	C. Hendrickson, Grafton. N. D.	May 14	2	105	23¾	50½	13.0	13.8
13	U. S. No. 8524	Seed	U. S. Dept. of Agriculture	May 14	2	101	23½	50¾	11.7	11.8
14	Common	Seed	Western N. Dak. Magill & Co.	May 14	2	101	19	52¼	21.4	23.4
15	Selected Riga	Fiber	Selected No. 5 N. D. Exp. Station	May 14	2	103	25	50¾	8.6	11.0
16	Selected Common	Seed	North Dakota Exp. Station	May 14	2	93	18¼	53¾	17.5	....

The Argentine sample again showed a tendency to produce large, strong blossoms of flax mounted upon very short stems, but it failed to yield as much as several of the other varieties, in fact it was one of the lighter yielding ones. This variety is a late maturing strain. The three Russian sorts, Nos. 7, 9 and 10, have made a good showing in their average yield for the past two years. The Argentine strain again failed to yield as much as common flax and that from the Russian selection, while the Siberian strains showed a low average, and the one from the United States Department of Agriculture and numbered by them 8524, again ranked very low in yield, but produced long enough fibre to indicate that it has been bred up for that purpose rather than for the production of seed. In the matter of height and consequent fibre production, however, it fell short of the performance of the Station's selected strain known as No. 15 in the table. It is interesting to note that the taller strains No. 12 Siberian, No. 13 (U. S. Department of Agriculture 8524), and the Station selection known as Selected Riga No. 15, all gave light yields of seed. When the yield of both seed and fibre is taken into account, Siberian flax No. 12 makes a strong showing. A study of the accompanying table indicates that the Russian, Siberian and Argentine importations of flax are not equal to those from the best of the common strains in this district, although the data which it gives covers but two seasons and cannot be taken as final evidence.

MILLET VARIETIES.

Twenty-four samples of millet seed coming from different sources were sown in the variety trial on the fourteenth day of May, 1903. The ground was in good condition and the millet was put in carefully, but owing apparently to cold and backward weather the growth was very scanty. It also seemed to be unfortunate in having its strongest growth period during dry weather, which resulted in its complete failure. The splendid showing which millet for seed and millet for hay have made at this Station during previous years causes the greater surprise that poor results were secured in 1903. Larger areas, which were sown in a field way, also proved a failure, the weed known as pigeon grass or foxtail having crowded in almost to the exclusion of the millet. The fact that our hopes had been built up by the records made with millet during the previous four years make the fact that it proved a failure in 1903 a more important observation than it would otherwise have proved. If millet seed is to prove a failure one year in five, or even one year in ten, it would be poor policy to depend upon it absolutely to furnish either hay or seed for stock food.

VARIETIES OF CORN.

Twenty-two varieties of corn were planted in the Station trials on May 16th, 1903. The land had produced wheat the previous season and was fall plowed. Three days previous to the time of planting it had been disced and harrowed in preparation. The ground was in good condition and the planter was set to put in the corn at a depth of three inches. The planter did a good grade of work and the soil conditions were satisfactory. On the 29th of May, thirteen days after planting, the corn was run over with a peg tooth harrow as a means of cultivating it and of destroying weeds. An iron lever harrow was used for the work, and the teeth were set with a backward slant so as not to dig too much. On the 9th of June it was cultivated with a Planet Junior cultivator and a few of the varieties were thinned to the required number of stalks per hill. It was given subsequent cultivation with the Tower surface cultivator as frequently as was necessary to keep the ground in good condition and free from weeds. On the 16th day of July the different varieties showed a very regular appearance in both growth and stand. The Station No. 100 variety, which represents ten years' breeding from the strain of Minnesota King, and No. 950, a Golden Dent strain, showed much better stands than the other dent varieties, and seem to have succeeded under the surounding conditions which the season allotted them better than did their neighboring sorts.

TABLE XVII.—VARIETIES OF CORN—CROP OF 1903.

Bulletin No.	Variety	Class	Where From	Stand	Stage of Maturity at Frost	Average No. of Stalks Per Hill	Height of Stalk—In.	Height of Ears—In.
100	North Dakota	Yellow dent.	North Dakota Experiment Station	Fair	Milk to dough	1 to 5	52	20
119	Golden Dent	Yellow dent.	Walter Russell, Fargo, N. D.	Fair	Milk to ripe	2 to 4	55	24
158	Fifty Day	Yellow flint.	H. D. Hurley, Duane, N. D	Good	Silk to milk	2 to 4	65	26
159	North Dakota Yellow	Yellow dent.	Oscar H. Will & Co., Bismarck, N. D.	Good	Milk	1 to 4	67	32
160	Will's Dakota	White flint.	Oscar H. Will & Co., Bismarck, N. D.	Fair	Milk to ripe	1 to 4	41	10
161	Will's Acme	Red dent	Oscar H. Will & Co., Bismarck, N D.	Poor	Milk to ripe	3 to 5	44	16
162	Will's Gehu	Yellow flint.	Oscar H. Will & Co., Bismarck, N. D.	Poor	Dough to ripe.	2 to 4	41	10
163	Will's Northwestern	Red dent	Oscar H. Will & Co., Bismarck, N. D.	Poor	Milk to ripe	2 to 5	50	16
164	Burleigh County	White flint.	Oscar H. Will & Co., Bismarck, N. D.	Poor	Milk to ripe	2 to 4	43	13
165	Longfellow	Yellow flint.	Northrup, King & Co., Minneapolis, Minn.	Good	Milk to ripe	2 to 5	65	26
166	University No. 13	Yellow dent.	Northrup, King & Co., Minneapolis, Minn.	Good	Milk	1 to 4	75	23
167	King Philip	Red flint	Northrup, King & Co., Minneapolis, Minn.	Good	Milk to ripe	1 to 4	67	24
168	Minnesota King	Yellow dent.	Northrup, King & Co., Minneapolis, Minn.	Poor	Milk to dough	1 to 4	50	23
169	Triumph	Yellow flint.	Northrup, King & Co , Minneapolis, Minn.	Poor	Milk to ripe	2 to 5	55	18
170	White Capped	Yellow dent.	Northrup, King & Co., Minneapolis, Minn.	Very poor.	Silk to milk	1 to 3	60	24
171	Smut Nose	Yellow flint.	Northrup, King & Co., Minneapolis, Minn.	Good	Milk	1 to 4	60	26
172	Pride of the North	Yellow dent.	Northrup, King & Co., Minneapolis, Minn.	Very poor.	Milk to dough	1 to 3	55	26
173	Rustlers White	White dent.	Northrup, King & Co., Minneapolis, Minn.	Very poor.	Milk	1 to 4	70	35
174	Mercer	Yellow flint.	Northrup, King & Co., Minneapolis, Minn.	Fair	Milk to ripe	1 to 5	65	24
175	Minnesota Leanning	Yellow dent.	Northrup, King & Co., Minneapolis, Minn.	Fair	Milk	1 to 5	68	26
176	Evergreen's Sweet	Sweet	Northrup, King & Co., Minneapolis, Minn.	Fair	Silk to milk	1 to 5	70	32
177	Elephant Fodder	Yellow dent.	Northrup, King & Co., Minneapolis, Minn.	Good	Silk	1 to 4	90	45

The flint strains averaged better in appearance than did the dent varieties, and were, as a whole, more advanced in their growth on July 16th. No. 158, fifty-day corn, made an extra good showing at that time and was just beginning to tassel.

No. 162, Will's Gehu, was nearly ripe on September 11th, and a statement was entered in the field record book at that time to the effect that it had the appearance of being the earliest of the entire list of varieties which we had planted. As killing frosts occurred on September 16th, the record entered in the tabular statement presented herewith gives the stage of maturity at that date. From the tabulated facts recorded in this report it will be seen that the later varieties tried in 1903 did not approach maturity. It should perhaps be explained that such expressions as "milk to dough," "silk to milk," "dough to ripe," etc., are expressions which mean the variation which a strain presented on September 16th. The earlier strains are short in stalk and have the ears too close to the ground for convenient and economical harvesting. The variety trials for 1903 harmonize with those of other years in showing that only the older sorts which we have grown in this district have ripened early enough to prove accessions to our list of varieties suited to this district. The trial also seems to indicate that such strains as North Dakota No. 100, Golden Dent, Northwestern or Northwestern Dent, Minnesota King and Acme represent the largest varieties which will prove serviceable in this district. It might also be said that Will's Dakota, Will's Gehu, Longfellow, King Philip, Triumph and Mercer are the flint strains which will prove most satisfactory for this state.

DRILLED CORN COMPARED WITH CORN IN HILLS.

The comparison of corn grown in drills at different distances apart with that of corn grown in hills, the rows standing forty-two and twenty-two inches apart respectively, was carried on in the season of 1903. The trial is really a continuation of one which has been running for six years, and is an interesting one in many of its details. The following systematized information in tabular form gives the yield, height and other points of interest carried out in this trial:

TABLE XVIII.—PLANTING CORN IN HILLS VS. PLANTING CORN IN DRILLS—CROP OF 1903.

Plot No.	How Planted	Height of stalks—In.	Yield Per Acre		Av. Yield Per Acre. Air Dry Fodder	
			Green Fodder—Pounds	Air Dry Fodder—Pounds	For Three Yrs.—Pounds	For Six Yrs.—Pounds
1	Drills 6 inches apart................	40	7,436	6,657	7,381	7,251
2	Drills 12 inches apart...............	42	4,869	5,701	6,512	6,651
3	Drills 18 inches apart...............	46	*........	....	....	....
4	Drills 24 inches apart..............	52	*........	....	....	....
5	Drills 30 inches apart..............	52	5,023	4,780	6,193	6,152
6	Drills 36 inches apart...............	55	4,384	4,937	5,929	6,021
7	Drills 42 inches apart...............	60	*........	....	....	....
8	Hills, rows 42 inches apart.........	58	*........	....	....	....
9	Hills, rows 22 inches apart.........	55	4 551	5,718	....	6,205

* Samples destroyed by mice.

A consultation of the table shows that corn planted in drills forty-two inches apart with the stalks growing close together in the drill row reached the greatest height of any of the plants and measured exactly five feet. That which was sown in ordinary wheat drills, six inches apart and thick in the row, reached the least height, the stalks measuring three feet and four inches. The gradual increase in height from three and one-third to five feet—the mark which the forty-two-inch trial plot showed—seems a logical result from crowding the thick planted corn together, as it would naturally produce a dwarfing effect. It is interesting to note further that the yield of air dry fodder in the six years' trial is the greatest from plots which were planted in six-inch drills. It is also interesting to note that corn grown in hills where the rows were twenty-two inches apart made a very much better showing than that which was grown in rows forty-two inches apart. Fodder which grew in drill rows thirty and thirty-six inches apart made good yields, and, by reason of growing far enough apart to allow of cultivation, it has an advantage over thickly seeded plots. The cultivation of corn during the growing season will conserve more moisture for the crop than can be done where the drill rows are too closely crowded together to permit the use of a corn cultivator. Thick planted corn has the advantage of producing small stalks which are less harsh than larger growing ones, and on that account are more palatable and surer to be consumed when fed to live stock. It is somewhat difficult to cut and cure corn fodder which has grown in six-inch drills, as no machine seems to work in it satisfactorily, except the ordinary mower, and the large stems contain so much sap that it is hard to dry them out thoroughly enough to make it safe to stack them for fodder.

Another portion of the trial with drilled corn consists of a comparison of corn planted in drill rows, three feet eight inches apart, with

the stalks growing at from six to thirty-six-inch intervals in the drill rows. This trial has been carried on for four years and gives average results that are worthy of careful study. The facts are presented in systematic order in the following tabular form:

TABLE XIX.—THICKNESS OF PLANTING CORN IN DRILL ROWS—CROP OF 1903.

Plot No.	How Planted	Height of Stalk—In.	Length of Ears—In.	Per Cent Ripe Ears	Yield Per Acre		Av. for Four Yrs.	
					Air Dry Fodder—Pounds	Ears—Bushels	Air Dry Fodder—Pounds	Ears—Bushels
1	3⅔ feet by 6 inches	56	5	47.0	6,078	39.1	7,078	34.8
2	3⅔ feet by 10 inches	58	6½	49.7	4,727	32.8	5,642	31.7
3	3⅔ feet by 12 inches	60	6½	44.4	4,457	28.7	5,766	27.9
4	3⅔ feet by 14 inches	60	6½	43.3	6,348	31.3	5,933	26.1
5	3⅔ feet by 16 inches	55	7	38.9	3,647	24.8	4,811	23.3
6	3⅔ feet by 18 inches	60	7	44.7	3,242	25.6	4,296	22.4
7	3⅔ feet by 24 inches	60	6½	48.7	3,242	15.1	3,656	16.4
8	3⅔ feet by 30 inches	55	7	43.7	2,701	20.7	......	....
9	3⅔ feet by 36 inches	60	7	47.9	2,566	15.7	2,977	....

An inspection of the above table shows a striking contrast in the yield of ears per acre. Beginning with a little over thirty-four bushels of ear corn from drill rows which produced corn stalks at six-inch intervals in the row, we find a gradual decrease in the yield of ears until we reach the plot having an interspace of twenty-four inches between the stalks. The yield of fodder also diminishes, but with a less degree of regularity, as the spaces between the stalks of corn in the row widen. It may also be seen that five to seven inches represent the extreme variation in the length of ears produced, and that there seems to be no evidence of a shortening of stalks which can be charged to thicker seeding. The ears of corn produced were appreciably longer on the thinner planted plots which had the stalks sixteen inches apart in the row than they were upon those that grew stalks of corn thicker than that interspace represents. The differences do not run regularly enough to justify a decided statement of a principle, but it is a significant fact that the thicker planted plots produced ears one and one-half inches shorter on the average than any other corn in the trial, and that the plots having stalks thirty to thirty-six inches apart in the rows produced as long ears as were grown upon any of the plots, and that the plants growing with sixteen and eighteen-inch intervals yielded ears of maximum length.

THICKNESS OF PLANTING CORN IN HILLS.

The best thickness to plant corn in the hill and in the drill row constitute important questions which are yet to be solved for this

district of county. The Station has continued its efforts in that field of investigation and is able to present herewith the results for the season of 1903. It is probable that a vast majority of North Dakota corn growers will find it more advantageous, in the production of different farm crops which go to make up the year's results, to plant corn in hills rather than in drill rows. It is not entirely a question of how much the yield of ear corn or of shelled corn will be, but also a question of destroying weeds and the cultivation effect upon the land, which must be considered.

That it is possible to keep corn which is grown in drill rows clean, cannot be questioned, but whether it is practicable to keep corn planted in drill rows clean, or whether the difference in yield will be large enough to pay for the added cost of hand work, constitutes an important question which must be taken into account. Realizing that a large proportion of the grain growers of North Dakota will continue to grow corn in hills, the Station has undertaken to determine whether thick or thin planting of stalks in a hill is preferable. The following table presents in detail the data secured:

TABLE XX.—NUMBER OF KERNELS IN A HILL—CROP OF 1903.

Plot No.	Number of Stalks	Height of Stalks—In.	Length of Ears—In.	Per Cent Ripe Ears	Yield Per Acre: Air Dry Fodder—Pounds	Yield Per Acre: Ears—Bushels	Av. for Four Yrs.: Air Dry Fodder—Pounds	Av. for Four Yrs.: Ears—Bushels
1	One	55	7	45.3	2,785	17.1	3,177	13.7
2	Two	60	7½	48.4	3,713	24.6	3,849	22.2
3	Three	60	6½	37.3	4,727	31.3	4,621	26.8
4	Four	58	6	32.0	4,322	30.5	5,134	27.6
5	Five	55	5	31.3	5,673	36.9	5,649	30.0
6	Six	55	4½	30.4	5,943	36.8	6,006	32.0

From the above table it will be seen that corn which produced six stalks in a hill gave a higher yield of both ears and fodder per acre—as an average result for four years' trial—than did that which was planted more thinly. It will be noticed, however, that the percentage of ripe corn in the season of 1903 was regularly reduced when the thickess was greater than two stalks in a hill. It will also be noticed that the ears were shortened as the thickness in the hill was increased, making the extreme variation range from four and one-half to seven and one-half inches. It is also interesting to note that the thin planted corn which produced but one stalk in a hill and the thick planting which produced five and six stalks in the hill, measured fifty-five inches in height, while that which produced two and three stalks to the hill measured sixty inches in height

or one-eleventh more than did their neighboring thicker and thinner planted sorts. The size or calibre of the stalks diminish with the thickness of planting. The Station hopes that at some future time it will be able to take up this question and carry it far enough to determine the percentage or the proportion of stalks which cattle will refuse when thick planted and thin planted corn is offered them, and also to determine the amount of dry matter that is produced which cattle will consume and digest. The above results present facts which should be used by the corn growers of the state. The Station cannot say of the thick and thin planting that one is better than the other, as too much depends upon how the grower is situated, but the trial shows that certain results may be expected from thin planting and certain results from thick planting, and the corn grower can understand from the trial what the results will likely be if he adopts one plan or the other.

DATES OF PLANTING CORN IN DRILL ROWS.

The results from two years' work in comparing corn planted at seven day intervals for six weeks following the date of May 18th, are presented herewith. The questions, how late may corn be safely planted for fodder, and what will the exact result be, as measured by the ripeness, the yield of fodder, the percentage of moisture in the crop, the class or grade of grain and fodder, and the difficulties which will be met in caring for and saving the crop, frequently arise among our fodder producers and grain growers. The following table gives the results in detail for both the six-inch and the forty-two-inch drill-rowed plats which constituted the trial:

TABLE XXI.—DIFFERENT DATES OF SOWING CORN—CROP OF 1903.

Plot No.	Date of Planting	Stand	Height of Stalks—In.	Stage of Maturity at Frost Sept. 16	Yield Per Acre			Av. Yield Per Acre For 1902–1903		
					Green Fodder—Pounds	Air Dry Fodder—Pounds	Water in Green Fodder—Per Ct.	Green Fodder—Pounds	Air Dry Fodder—Pounds	Water in Green Fodder—Per Ct.
				SIX-INCH DRILLS.						
1	May 18...	Good........	36	Silk to milk...	18,945	8,560	60.4	15,652	6,809	62.4
2	May 25...	Good........	38	Silk to milk...	14,850	5,406	68.1	13,180	4,622	69.5
3	June 1...	Very heavy..	40	Silk	20,565	6,594	71.9	18,231	5,728	72.6
4	June 8...	Very heavy..	45	Silk	22,950	7,228	72.4	16,664	4,887	75.5
5	June 15..	Good........	40	Silk	20,115	6,105	73.4	17,275	5,087	74.4
6	June 22..	Good........	45	Silk	21,870	7,782	68.4	......	.....	....
				FORTY-TWO-INCH DRILLS.						
1	May 18...	Very good...	60	Dough to hard	11,173	*....	....	10,774	.....	....
2	May 25...	Good........	65	Milk to hard..	11,986	*....	....	10,390	.....	....
3	June 1...	Very heavy..	65	Milk to dough	16,583	6,906	63.5	12,788	4,506	71.5
4	June 8...	Very heavy..	70	Milk...........	16,547	5,094	73.0	10,843	3,122	76.7
5	June 15..	Very heavy..	68	Silk to milk...	16,680	4,720	75.2	12,985	3,696	75.0
6	June 22..	Fair.........	60	Silk	7,284	2,967	64.3	......	.....	....

* Samples destroyed by mice.

By consulting the table presented above it will be noted that the corn planted May 18th and May 25th, in six-inch drills, reached the silking stage and had a portion of the ears reach the milk stage of growth. It will also be noted that the amount of water which the crop contained on September 16th, when frost cut short its growth period, increased gradually with the lateness of sowing. The results for the season of 1903 were a little irregular in the amount of water which the crop contained, giving the highest percentage of water in the fodder sown June 1st, 8th and 15th. The average results for the two years, however, run nearly uniform. The sample containing the most moisture shows thirteen pounds per hundred more of water, or nearly one-fourth more moisture, which must be dried out in curing the fodder into dry form. It will be noted that the late planted corn from drill rows six inches apart yielded less fodder than the earlier planting, and also that the late planted corn fodder yielded over two and one-third tons of dry matter per acre. Too much importance, however, must not be placed upon the results from two years' work. In this, as in several other trials with corn, the poor facilities which the Station buildings afford for handling experimental fodder and grain, force us to record blank columns, with a foot note giving the information that the samples were destroyed by vermin or by other unavoidable

occurrences. Corn planted in the trial of different dates of seeding in forty-two-inch drill rows, gives much the same comparative results as come from the trial of seeding it in six-inch drills. A greater difference is recorded for the degree of maturity or ripeness of the early and late sown plots. Corn planted in drill rows forty-two inches apart produced a considerable amount of its value in the ears of corn which it formed, and the difference in the stage of maturity of the corn from the different trial plots represents more of feeding value than it does when it is from thicker seeding. The percentage of moisture which the late seeded corn is likely to contain is less a hindrance in the fodder produced from forty-two-inch drills than it is in fodder grown in drills six inches apart. The corn from forty-two-inch drills can be bound, shocked and field cured in the ordinary way without much danger of heating or molding, while corn planted in six-inch drills must be cut down with a mower and allowed to lie in the swath until it has dried sufficiently to permit of stacking. The shorter days and the cooler weather, which come at the season when frosts occur and the crop must be harvested, cause great difficulty in curing and drying out the fodder from thick sown corn. Further comment on this trial will be reserved until the results secured during future seasons may be added to the data which is now at hand.

A CULTIVATION TRIAL WITH CORN.

For four years the Station has carried on a series of cultivation trials as a part of the corn work undertaken. The trials comprise a comparison of deep cultivation, which is commonly produced by using the pointed shovel cultivator during the entire season, with another plot of corn which is cultivated shallow during the first half of the season and cultivated deep with a pointed shovel cultivator during the latter half of the season. A third trial plot was cultivated deep during the first half of the season and shallow during the latter part of the corn cultivating period. The fourth plot in the trial was cultivated with a surface cultivator each time during the season. The corn in all of these trials was planted at the same time and under the same conditions in every way. The following summarized results give in tabular form the facts concerning the trial:

TABLE XXII.—CULTIVATION EXPERIMENTS WITH CORN—CROP OF 1903.

Plot No.	Method of Culture	Height of Stalks—In.	Stage of Maturity at Frost Sept. 16	Per Cent Ripe Ears	Yield Per Acre		Av. For Four Yrs.	
					Air Dry Fodder—Pounds	Ears—Bushels	Air Dry Fodder—Pounds	Ears—Bushels
1	Deep	60	Some hard, mostly dough	34.6	6,280	35.5	4,593	....
2	Shallow, early; deep, late	55	Dough, mostly hard	42.4	6,112	36.4	4,712	....
3	Deep, early; shallow, late	60	Some ripe; dough, mostly hard	45.9	6,171	34.3	4,362	....
4	Shallow	60	Mostly dough; some ripe	47.8	5,977	35.2	5,058	....

From the above table it will be seen that the yield of air dry fodder as an average for the four years gives the greatest results from shallow cultivation. It will also be seen that there was little difference between the other three plots as measured by the yield of air dry fodder. The result of the trial for one of the earlier seasons indicated that deep cultivation late in the season has a tendency to cause an early ripening of the ears, but the results for the season of 1903 indicate that the killing frost which occurred September 16th found the shallow cultivated plot with the largest portion of ripe ears. The plot receiving shallow cultivation during the latter half of the season was next to the shallow cultivated one in the proportion of ripe corn, and the plot which received deep cultivation had only a little over one-third of the ears ripe. The notation in the table should, perhaps, be explained in this connection, as it is difficult to find a short form of wording that will express the idea which the authors had in mind. Such expressions as "dough mostly hard" really means that the most of the ears of corn are in the latter part of the dough stage, or what is called the hard dough stage.

The amount of data which has been secured upon the yield of ears from the different plots is limited, owing to the lack of suitable facilities for drying and curing corn fodder in a place which is free from vermin.

OTHER FORAGE CROPS.

Kaffir corn, amber cane or sorghum, and pencillaria, are three other forage plants which were given a trial in 1903. They were so late in maturing that none of them were headed out on September 16th, when killing frost overtook them. Amber cane gave the greater promise of the three, but none of them were sufficiently successful to be considered competitors of the better strains of corn. The

pencillaria was slightly handicapped by having been planted four days later than the sorghum, Kaffir corn and corn varieties discussed in this report.

VARIETIES OF POTATOES.

Owing to the lack of suitable place for wintering seed potatoes and to the shortage of funds for carrying on experiments with field crops, the trials with potatoes were practically eliminated for the season of 1903. Short rows of each of twenty-two varieties were propagated in order that seed of the better strains which the Station has in stock might be preserved. Owing to the heavy rainfall during the fall season, the potato ground was flooded in irregular spots in such a manner that it was impossible to accurately figure out the yields.

The seed of most of the strains of potatoes which were planted was very scabby. The seed was treated with the formaldehyde treatment and the resulting crop was clean and marketable.

ALFALFA TRIALS.

Turkestan Alfalfa.—The Turkestan strain of alfalfa, seeded in 1901 and reported upon in the Thirteenth Annual Report of this Station, failed to pass the winter of 1902 and 1903 successfully, having been badly winter killed. It was given the most trying conditions by having all of its stem growth mowed close to the ground just before the cold weather of fall began.

A second plot of Turkestan alfalfa, seeded in the spring of 1902, which was left a growth of stems a few inches high, killed but little during the winter.

The question of alfalfa living through the winter seems to be the only serious one to answer relative to its successful production in North Dakota, and the matter of leaving a slight growth of stems in the fall is a simple plan which may prove a remedy for winter killing.

The plots were sown broadcast at the rate of fifteen pounds per acre upon land which had been given a preparation similar to that which is usually made for wheat. The seed was covered by running over the land with a peg-tooth harrow. It was sown at the latter part of the wheat sowing time, upon land which was made free from weeds by a previous thorough harrowing. It is best sown without a nurse crop of any kind, as the young alfalfa plants are rather tender and do not stand crowding.

The mower was run over the field, with the cutting bar set high, frequently enough to prevent the smothering effect of the weeds and to keep the weed seeds from maturing and finding lodgment in the soil.

Grimm Alfalfa.—The Grimm strain of alfalfa, which was sown in 1902 upon ground adjoining the Turkestan trial, has proved

more thrifty and vigorous than the Turkestan strain has done. The Grimm alfalfa filled its seed pods with plump, ripe seed somewhat better than the Turkestan variety, while plants descended from Utah seed yielded an abundance of shriveled and emaciated seed which had little growing strength. The Grimm strain is descended from original plants which had survived for about twenty years in the vicinity of St. Paul, according to the statement of Professor Hays of the Minnesota Station, who brought the seed to the attention of this Station.

This department of the Station proposes to enlarge its work with alfalfa during the coming season, with the hope that it will be able to secure results which will carry it beyond the experimental stage, at which point it must be said to belong at the present time.

RED CLOVER TRIALS.

The trial of clovers from different states and countries, described in the Thirteenth Annual Report, gave some additional data in the season of 1903. The plots have become irregular, owing to the flood in the season of 1902, that data upon the yields made cannot be secured with any considerable degree of accuracy, as some of the plots are so much smaller than others that a comparison could not be considered entirely fair, and the jagged edges and irregular shapes caused by the flood makes the determination of the size of the plots almost impossible. As the chief object of the trial, which is carried on in co-operation with the United States Department of Agriculture in conjunction with Dr. A. J. Pieters, is to learn the degree of hardiness and study the conformation and vigor of the plants, rather than to determine what yield results might be obtained from a field trial, the objects sought are not entirely thwarted. A study of the hardiness and thrift of individual plants has been the chief work of the trial. So far none of the introduced seeds have shown as many favorable characters as the plants which have been produced from seed descended from clover which has been grown in this district for a number of years. The greatest difference in the performance of the plants is noted in the degree of filling and of ripening seed. In the season of 1903, the Minnesota, Michigan and Tennessee strains made the best showing, as measured by the amount of plump and valuable seed produced. In 1902, the Minnesota, Canadian and Tennessee strains were outstanding in the matter of seed production, and it seems probable that the Canadian plot might have repeated its last year's performance this season had it not been accidentally destroyed. As already noted, trials partaking of the nature of the one under discussion require a number of years of record to merit much consideration.

A one-third acre plot, among the rotation trials, which was seeded to clover with wheat as a nurse crop in 1902, made an excellent stand the past season, and had reached a height of twenty inches

on June 25th, upon which date it was harvested. It made a yield of 3,615 pounds of hay per acre, or practically the same as the plot of mixed timothy and clover which grew along side of it, about 400 pounds more than the plot of pure timothy and 400 pounds less than a plot of brome grass. The trial indicates that the plan of sowing clover at the rate of fifteen pounds per acre with a nurse crop of wheat, and harvesting one crop of hay before plowing it under, is the most promising plan for clover growing in the Red River valley. When such a plan is followed the land does not lie idle at all, as a crop of wheat is produced as a nurse crop the season when the clover is seeded. If clover does not "take," the land can be plowed up and put into wheat the next year with only the expense of providing the clover seed and putting it in. The effect on succeeding wheat crops is noticeable in this trial, and indicates that it may be an advisable plan to follow on account of helping to increase the fertility of the soil. The plan outlined seems more promising and practical than an attempt to leave clover for a permanent meadow. The Station has had better success in carrying a crop of clover through the first winter than through succeeding winters, probably owing to the protection of the wheat stubble, and possibly owing to a greater vigor and endurance of young clover plants. The seed used in this trial was that of the common or medium red clover, which was bought on the local seed market and was doubtless grown in the northwest.

OTHER TRIALS.

A number of experiments in animal feeding and pasturing and an extensive one upon the rotation of crops are not in form to offer in this publication, and will be presented at some future time.

J. H. SHEPPERD.
E. G. SCHOLLANDER,

ACKNOWLEDGMENTS.

My thanks are due to Prof. J. C. McDowell for efficient aid in preparing this report.

C. J. Zintheo, formerly Instructor in Farm Mechanics in the College, rendered me aid in investigations reported upon herewith, at various times during the summer of 1903.

I am indebted to Prof. E. S. Keene, of the Mechanical Department of the College, for aid in securing permanent records in the form of photographs of particular features of the work of the past season.

The report of this department is hereby respectfully submitted.

J. H. SHEPPERD.

THE EDGELEY SUB-EXPERIMENT STATION.

To Director J. H. Worst:

SIR: The last legislature appropriated the sum of $5,000 per annum, to be expended in equipping and operating the Sub-Experiment Station at Edgeley, LaMoure county, North Dakota. The Station grounds consist of a quarter section of land, which was donated to the state, about ten years ago, by the citizens of Edgeley and vicinity, to be used for experimental purposes. The last legislature was the first which saw fit to appropriate more than $250 to carry on the work. This amount was found to be wholly inadequate for the needs of the Station in inaugurating a systematic and intelligent line of experiments, which would be of value to the people producing crops in that district.

The radical difference in the climatic and soil conditions of the central and western portion of the state from those prevailing in the Red River valley make the need almost imperative that a system of experiments be made at some point outside the Red River valley, to meet the needs of the producers located in that portion of the state. As the climatic and soil conditions of the country around Edgeley seem similar to those of a vast district in the state, that place was chosen as a suitable location for the Sub-Station. The experiments carried on at the Edgeley Sub-Station should be especially valuable to the farmers of the central and western portions of the state.

In the past little difficulty has been experienced in obtaining an abundant supply of coarse forage and hay from the vast areas of unbroken prairie, but, as the population is rapidly increasing, the time is at hand when much of the wild land will be broken up and turned to the production of other crops. Considerable attention will be given, at this Station, to growing fodder, hay and forage crops, to supplement the restricted acreage of wild hay which a more intensive system of farming has brought about.

The Station is situated in what is sometimes called the semi-arid belt of North Dakota. A series of experiments, constituting a study of promising systems of crop rotation and practical tillage methods for the conservation of soil moisture, should accumulate important data as time passes. The annual rainfall at Edgeley is not very different from that of the Red River valley, but the soil conditions represent such a marked difference that methods of farming which tend to conserve or hold moisture in the soil for the utilization of a crop are of much greater importance to the farmers of that portion of the state.

Barn and Office, Edgeley Sub-Station.

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The influence and value of trees and hedges on a farm as a shelter belt and for ornamental purposes can scarcely be estimated in dollars and cents. The Station proposes to give a large amount of attention to the culture of forest, ornamental and fruit trees, in an attempt to determine the ones which are best suited to the climatic and soil conditions of the locality. The culture of small fruits and vegetables is also an important feature that will receive attention.

During the past season, the work has been of a general rather than of a special nature, due to the necessity of equipping the Station at a period late in the spring. The work has been handicapped to a considerable degree by a lack of suitable machinery and through an insufficient number of work horses. When due consideration is given to the necessary outlay for inaugurating and carrying out work of this character, it will be found that $5,000 is a small sum to devote to equipping a station with suitable apparatus, implements, machines, material, buildings, etc. As the work of investigation progresses and broadens, the expense of carrying the plant will doubtless increase proportionately.

At the present time, about ninety acres of the farm are under cultivation, and the remaining portion consists of unbroken prairie sod. All of the cultivated land was cropped during the season of 1903. As no appropriation was available in 1902 to carry on the work started at the Station the previous year, no soil preparation was made for the crop of 1903. The ground had to be plowed and otherwise prepared for seeding after spring opened, which delayed the work considerably. Owing to delay caused by spring plowing and other general preparations, the period of seeding was very late.

GENERAL FIELD WORK.

In the general field work of the past season the plan has been to grow enough feed to supply the needs of the Station live stock during the season of 1904. Fifteen acres were sown to oats, five acres to barley and two acres were sown to emmer or spelt. The land has been cropped continuously for the past twelve or fifteen years without any special regard to retaining the fertility of the soil, hence these crops were necessarily light in yield. About twelve acres were planted to Golden Dent corn on April 27th and 28th. The corn came up well, made an excellent stand and produced a fair quality of fodder. The severe windstorms of early fall, which were prevalent before the corn was harvested, severely injured the crop by stripping off the blades from the stalks, in addition to bending and lodging the stalks in a way which interfered badly with the work of the corn binder. A very small percentage of the corn matured, as it was killed by frost on September 14th. The yield of fodder was estimated at two tons per acre.

Pasture.—Twenty acres was sown to brome grass to provide a permanent pasture for stock. The seed was sown broadcast with an old Superior seeder at the rate of twenty-five pounds per acre. A

light harrow followd the seeder and did good work in covering the seed. The weeds were kept down by the use of a mower at needed intervals. An excellent stand of grass resulted from this method of treatment.

Fencing.—During the past summer almost the entire farm has been enclosed with a fence consisting of three strands of barbed wire. The fencing was deemed necessary to protect outstanding hay stacks and trees from the depredations of stray herds of cattle and horses.

TREES AND HEDGES.

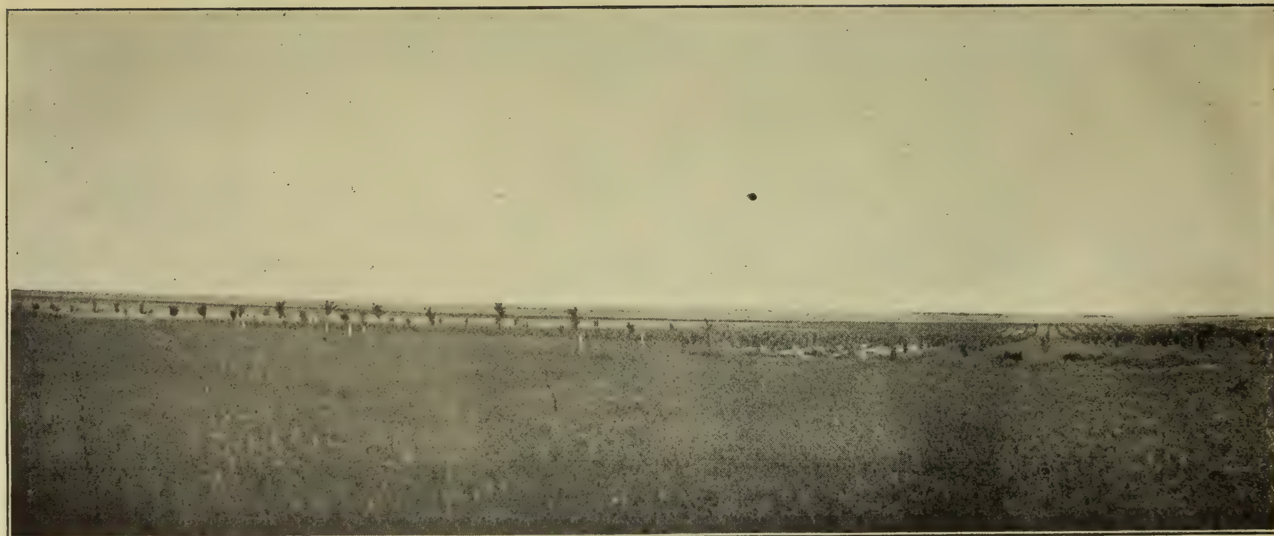
Considerable attention has been given to the culture of trees and hedges during the past season. About 8,000 two-year-old seedling trees were set out upon a plot of two and one-half acres of ground. These include some of the most hardy varieties of forest trees, such as elm, soft maple, box elder and ash.

The seedlings were alternated in such manner as to give them forest conditions. A space of eight feet was left between the rows of trees, and an interspace of two feet was made between the trees in the row. Part of the trees received a heavy mulch of straw immediately after being set out, while the remaining ones were given the best possible shallow cultivation and kept free from weeds during the entire season. The trees on the cultivated portion of the ground appeared to be more thrifty and made more growth than those surrounded by the straw mulch.

A hedge of the Golden Russian willow was started along the west boundary line of the farm from cuttings obtained at the Central Station at Fargo. The cuttings were put in rather late in the season, but they made a fairly good growth, with the exception of a few on the higher portions of the land. These failed to survive.

Fruit Trees.—The varieties of fruit trees, which were obtained from a Minnesota nursery firm, were five years old at the time of setting them out. These included some of the most hardy and popular varieties grown in the northwest. Thirty plum trees were set out, including six of each of the following varieties: Wyant, Forest Garden, Rolling Stone, Desota and Surprise. The apple trees planted include six of each of the following varieties: Duchess, Wealthy, Haas, Hibernal, Lyman's Prolific and Patten's Greening. All of the varieties of apple and plum trees did well, made a good growth and gave promise of being hardy and well adapted to surrounding conditions.

A number of varieties of currant, gooseberry and raspberry bushes were set out at a late period in the spring. This lateness of setting out evidently accounts for the poor showing made by some of the varieties, especially the gooseberries, which made but little progress in growth. The currant and raspberry bushes did exceptionally well.



Tree Planting, First Year, Edgeley Sub-Station.

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LAWN AND BUILDING SITE.

About six acres were laid out for a lawn and building site. This ground was sown to brome grass at the time the pasture was seeded. The lawn was sown by hand and possibly a little less seed was used. The brome grass sown upon the lawn, like that seeded for pasture, made an excellent stand. A heavy rain which fell just after the brome grass was sown proved very beneficial in germinating and starting the seed. To beautify the lawn, a number of clumps of trees were planted on it at suitable places. The trees used in this planting include the North Carolina poplar, basswood, elm, etc. A number of Black Hills spruce and some flowering shrubs, such as the snowball, common lilac, Persian lilac, barberry, etc., were used to fill in the clumps. Only two-thirds of the evergreens survived the hot summer winds. C. B. Waldron, Horticulturist of the Central Experiment Station, assumed the responsibility of laying out the lawn and building site, also the planning and direction of the work done with trees and hedges.

BUILDINGS.

To supply the urgent needs of the farm, a barn and a general office building were erected. While plain in their architecture, these buildings are practical in their appointments, and serve the purposes of the Station very well. The office is large enough to supply an office room for the superintendent of the Station, besides three other rooms, which will be used for storing seed, grain samples, etc. This building is twentw feet by twenty-four feet, one story high, and has an elevation of ten feet. The barn is a plain rectangular building, thirty feet by fifty feet, with an elevation of sixteen feet. It is provided with six single stalls for horses, two grain bins ten feet by ten feet, one general tool room ten feet by ten feet, and has in addition a space twenty feet by thirty feet for storing machinery. The hay mow has a storage capacity which will accommodate about twenty tons of hay. Ventilation is provided by a four feet by six feet cupola. The barn is floored with the best grade of fir flooring. A driveway nine feet wide extends the entire length of the building. Both buildings rest on a stone foundation eighteen inches in width.

GRAIN AND FORAGE CROPS.

Brome Grass.—Owing to the cold, late spring and unfavorable season, brome grass did not yield as well as in previous seasons. The brome grass showed its superiority over the wild native grasses in making a growth of four to six inches before the latter had started in the spring. The grass on plot 1 was allowed to ripen its seed, and was cut with a common grain binder July 16th. When threshed at a later period, this plot gave a yield of 300 pounds of seed per acre. The yield of hay was estimated at one and one-quarter tons per acre.

On plot 3 the stand of brome grass was very thin, making a growth of only two and one-half feet, yielding three-fourths ton of hay and 150 pounds of seed per acre. The poor yield of hay and seed on this plot was attributed to a very thin stand, which furnished little shade to the ground. This caused the dry weather to have much greater effect upon it.

Turkestan Alfalfa.—The east half of plot 2, sown to alfalfa in 1901, was a failure the past season, only making a growth of eight inches. The stand was very thin over the entire plot, and the color of the plants was yellow, indicating a weak, unhealthful growth. On July 8th it was nearly all brown and dead, and was cut with a mower. One-half of the hay was left on the ground and one-half removed. This was done in order to note the effect of this treatment upon the following crop of alfalfa. The west half of plot 2, sown to alfalfa in 1902, winter killed almost completely during the past winter. Upon examining the roots of the plants that survived the winter, it was found that many of them possessed tubercles peculiar to the leguminous class of plants. The ground was again plowed in the spring of 1903 and sown to alfalfa. Owing principally to the unfavorable season, the result was again a poor stand.

Timothy.—The timothy sown on plot 9 in 1902 made a good start early in the spring, but proved to be almost a total failure later in the season during the drouthy periods. On July 8th it was noted that the timothy had made a growth of ten inches, and that it had been killed by hot winds previous to that date. About one-half of the timothy was headed at that time, but the heads were very short. The timothy was mowed and one-half left upon the ground, as in the case of the alfalfa.

Corn.—Plots 5 and 9 were planted to corn on May 25th. The land was spring plowed and harrowed twice before planting. A hand planter, regulated to drop from two to four kernels in a hill, was used in the trial. The seed was planted in rows three feet six inches apart, with the hills three feet apart in the row. The corn on plot 5, which grew a crop of corn in 1902, did very poorly during the entire season, while that on plot 9, which produced a crop of wheat in 1902, made an excellent stand and produced a fine quality of fodder.

Flax.—The flax crop on the different plots was very poor. A heavy rain, which fell two days after the flax was sown, probably accounts to a great extent for the poor stand of straw. The rain puddled the soil badly, causing it to form a hard crust over the surface. Upon examination, it was found that many of the flax grains had turned dark in color and failed to germinate, while others were unable to push through the crust of earth. The thin stand allowed the Russian thistle to make a heavy growth, thereby crowding the crop badly and doing much damage to the crop of flax. A comparison of the effect of deep and shallow plowing on the yield of flax is shown in plots 17 and 18. Plot 17 was plowed four inches deep

and plot 18 seven inches. In general appearance, growth and yield there was practically no difference in the two plots. Plot 4, following a crop of wheat, produced about the same yield. Plot 12, sown to flax continually, gave a yield of practically one bushel less per acre than the other two plots. The flax on all of the plots was very uneven and spotted in appearance. No flax wilt was observed.

Rape.—Plot 16 was plowed and sown to rape. This plot was very low and alkaline in spots. The rape was sown with a single disc drill regulated to sow about three pounds of seed per acre. Every fifth drill cup was used, thus making the distance between the rows twenty-four inches. The rape came up well and made an excellent stand. On September 30th it was noted that the rape had made a growth of two feet in height, being large and leafy in character, and almost filled the spaces between the rows. The rape received three cultivations at needed intervals. A small shovel one-horse cultivator was used in cultivating it. The yield per acre was estimated at ten tons.

A comparison of the results obtained in this experiment with those of previous seasons made at the Station clearly demonstrates the value of rape as a forage crop for the central and western part of the state. The Central Station at Fargo has already shown the value of rape for the Red River valley.

Millet.—Plot 15, which had grown a crop of oats in 1902, was sown to millet (Siberian) on May 29th, with a Monitor shoe drill set to sow one-half bushel of seed per acre. The millet made fair growth, but was killed by the heavy frost on September 14th before much of it had headed out. The yield was estimated at two and one-half tons per acre.

Wheat.—Plots 7 and 8 were sown to wheat on April 26th. The land was harrowed twice before and once after seeding. This was a trial to show the effects of deep and shallow plowing on the crop. Plot 7 was plowed four inches deep, and plot 8 seven inches deep. Both plots received the same treatment at seeding time, and were sown at the rate of one and one-fourth bushels of seed per acre. Close observation, during the entire period of growth and at the time of harvesting, failed to show any marked difference in the grain growing on the two plots, except that plot 7 appeared to be somewhat better filled than plot 8. These plots were ripe and harvested on August 11th. A comparison of the yield of the two plots shows a difference of seven-tenths of a bushels in favor of the shallower plowing.

Plots 11, 13 and 14 were sown to wheat April 26th. A Monitor shoe drill was used, which was regulated to sow one and one-fourth bushels per acre. These plots grew the following crops in 1902: Plot 11 is a wheat continuous plot; plot 13, wheat; plot 14, millet. The wheat continuous plot has not been in the trial a sufficient length of time to show any marked effect upon the yield.

Table VII gives the data and yield for the grain and forage crops:

TABLE VII.—GRAIN AND FORAGE CROPS, GROWN IN A ROTATION TRIAL.

Plot No.	Crop Grown	Days Maturing	Length of Straw	Length of Head—In.	When Harvested	Yield Per Acre
1	Brome grass..................	....	3 feet....	6 inches..	July 16..	1¼ tons.
2	Turkestan alfalfa............	....	8 inches..	....	....	¼ ton.
3	Brome grass..................	....	2½ feet..	6 inches..	July 16..	¾ ton.
5	Minnesota King corn.........	....	3½ feet..	....	Sept. 20..	1½ t'ns fodd'r.
6	Common flax..................	90	20 inches	....	Aug. 18..	6 bu. 49 lbs.
7	Wheat.........................	108	2½ feet..	....	Aug. 11..	17.28 bu.
8	Wheat.........................	108	2½ feet..	....	Aug. 11..	16.57 bu.
9	Corn..........................	....	3½ feet..	....	Sept. 20..	2 tons.
10	Timothy.......................	....	10 inches	....	....	¼ ton.
11	Wheat continuous.............	96	2½ feet..	3 inches..	Aug. 6...	15.68 bu.
12	Flax continuous..............	90	2½ feet..	3¼ inch's	Aug. 18..	5.34 bu.
13	Wheat.........................	102	2 feet....	2½ inch's	Aug. 5...	15.17 bu.
14	Wheat.........................	102	2 feet....	2½ inch's	Aug. 5...	16.55 bu.
15	Millet........................	....	2 feet....	....	Sept. 15..	2½ tons.
17	Common flax..................	90	20 inches	....	Aug. 18..	6.57 bu.
18	Common flax..................	90	20 inches	....	Aug. 18..	6.32 bu.
22	Rape..........................	....	2 feet....	....	....	10 tons.

VARIETIES OF WHEAT.

Nine varieties of wheat were grown in the trial in 1903. These varieties were selected from the Central Station at Fargo as promising varieties for the central and western portions of the state. The land used in the trial was summer fallowed in 1902, and was prepared for the crop by double discing and harrowing twice before the seed was sown. On April 24th the grain was sown with a Monitor shoe drill regulated to sow five pecks per acre for the fife and blue stem and six pecks per acre of macaroni seed. All of the seed was given formaldehyde treatment for smut. As the grain was somewhat swollen at the time of seeding, due to the formaldehyde treatment, allowance was made for the increase in bulk by measuring a bushel before and after treating. Owing to the late, cold spring, the wheat was slow in coming up, but stooled well and made an excellent stand. During the entire season the macaroni varieties had the appearance of being more thrifty than either the fife or blue stem, and they were not so badly affected by drouth. This difference was especially noticeable during the earlier and later periods of growth, during which time the rainfall was light and irregular. The macaroni wheat was less affected by the hot winds at the time of filling than were the fife and blue stem strains. During drouthy periods the fife and blue stem burned out badly in spots, and the straw became very brittle and brown in appearance upon the affected patches, while the macaroni maintained a more healthful appearance. These drouthy spots were distinctly noticeable during the growing season of 1903 over the entire farm and also

upon adjoining land, and wherever they occurred the grain had immature straw and carried short heads, which were only filled with shrunken kernels.

The following table gives the data and yield for the varieties of wheat in 1903:

TABLE I—VARIETIES OF WHEAT.

Variety	Class	Where From	Days Maturing	Length of Stem—In.	Bearded, Smooth or Velvety	Length of Heads—In.	Weight Per Bushel—Pounds	Yield Per Acre—Bu.
Minnesota 169	Blue stem	North Dakota Experiment Station	108	36	Velvety	3¼	56½	15.06
Haynes' Selected	Blue stem	North Dakota Experiment Station	106	36	Velvety	3¼	58	15.74
Rysting's Fife	Fife	North Dakota Experiment Station	101	34	Smooth	3½	56	19.74
Minnesota 163	Fife	North Dakota Experiment Station	101	32	Smooth	3	58	17.06
Aronautka	Macaroni	L. A. Ueland, Edgeley, N. D.	97	32	Bearded	2¼	58	19.38
Kubanka	Macaroni	North Dakota Experiment Station	97	32	Bearded	2	60	18.22
Pererodka	Macaroni	North Dakota Experiment Station	97	36	Bearded	2¼	61½	21.41
Velvet Don	Macaroni	Nortn Dakota Experiment Station	97	34	Bearded	2¼	61½	20.32
Yellow Gharnovka	Macaroni	North Dakota Experiment Station	97	34	Bearded	2¼	61½	20.59

The macaroni varieties were ripe and harvested on August 3d. Judging from the general appearance, viz., stand, stooling and filling at that time, the varieties stood in the following order: Rererodka, first; Velvet Don, second; Yellow Gharnovka, third; Kubanka, fourth; Aronautka, fifth. The Aronautka contained a mixture of about 10 per cent of fife heads, which might reduce the yield somewhat. The heads of the macaroni varieties were short but well filled.

Rysting's fife was ripe and harvested August 4th; Minnesota 163 (fife), August 7th; Haynes' selected blue stem, August 12th; No. 169 (blue stem), August 14th.

Table II gives the comparative yield between the two best yielding varieties of macaroni, the two varieties of fife and the two varieties of blue stem:

TABLE II.—SHOWING COMPARATIVE YIELD OF BLUE STEM, FIFE AND MACARONI WHEAT.

Class	Yield Per Acre—Bu.	Difference —Bu.
Macaroni	21.0	....
Fife	18.40	2.60
Blue stem	15.40	5.60

It will be observed that the macaroni strains yielded two and six-tenths bushels more per acre than the fife, and five and six-tenths bushels per acre more than the blue stem. It will also be noticed that the fife yielded three bushels more per acre than the blue stem. There was little difference in the grade of fife and blue stem wheat, as both were badly shrunken.

Macaroni wheat seems to be particularly adapted to the central and western portion of North Dakota. The results of trials at the Edgeley Station indicate a superior yielding capacity and a power to resist drouth and hot winds. The discrimination made against it by the millers and elevator men is gradually being overcome as the value of macaroni flour becomes more widely known.

VARIETIES OF OATS.

Five varieties of oats were grown in the trial of 1903. The varieties used in the trial, with the exception of one sort, were obtained from the Central Station at Fargo, and include some of the earliest and best yielding varieties grown there. The Swedish select oat is a variety recently imported from Russia. All of the varieties were sown April 28th on land that had grown a crop of corn in 1902. On account of weeds which sprang from seed that matured the previous season, it was deemed advisable to plow the land before sowing the oats. A low, wet swale which passed through the central part of this plot, caused that portion to be unsuitable for the trial, as it was too wet to be properly tilled. The ground was harrowed twice before seeding. A Monitor shoe drill, set to sow oats at the rate of two bushels per acre, was used. This drill was provided

with chains and did good work in covering the grain. The oats stooled well, except in the low portion of the plot, and made an excellent stand. Upon the low land the stand was very uneven. None of the strains of oats rusted seriously enough to damage the crop.

The oats were ripe and harvested on the following dates: Sixty Day oat, July 20th; Swedish Select oat, July 30th; Minnesota 202 and Siberian White, August 3d; Select Tartarian, August 11th.

Table III gives the data and comparative yield of the different varieties:

TABLE III.—VARI ETIES OF OATS.

Variety	Where From	Days Maturing	Length of Straw—In.	Form of Head	Length of Head—In.	Color of Berry	Size of Berry	Shape of Berry	Wt. Per Bu.—Lbs.	Yield Per Acre—Bu.
Minnesota 202	North Dakota Exp. Station	97	36	Whorled	7½	Light Yel.	Medium small	Short; slender	35	48.56
Siberian White	North Dakota Exp. Station	97	36	Whorled	7½	White	Medium large	Medium long	34	46.28
Sixty Day Oat	North Dakota Exp. Station	83	36	Whorled	6	Yellow	Medium small	Medium short	34	37.02
Select Tartarian	North Dakota Exp. Station	105	36	Side	8	White	Medium large	Medium long	37	31.94
Swedish Select	Russia	93	33	Whorled	6½	White	Large; plump	Short; plump	38	41.38

It will be noticed that the varieties having a medium season of growth gave the largest yield of grain, the earliest maturing strain second and the latest maturing third. General conclusions cannot be formulated upon the results secured from one season's work, as further trials may produce different results.

The variety known as Swedish Select gave very promising evidence of becoming one of the best strains. It produced a stiff straw of good height, had well filled heads with large plump kernels and ranked first in weight per bushel.

VARIETIES OF BARLEY.

Four varieties of barley were grown upon the trial plots of the Station in 1903. The land upon which the trial was made grew a crop of corn in 1902. All of the varieties were previously treated for smut with the formaldehyde treatment, and were seeded on April 28th with a Monitor shoe drill regulated to sow at the rate of two bushels per acre. The barley made a fairly good stand, but, like other grains, suffered from a lack of moisture at a critical period of growth, which caused the straw to be very short and brittle at the time of cutting and most of the heads were poorly filled. The kernels in the Manscheuri and Six-Rowed Mansury varieties were somewhat under size. McEwan's Hulless, Manscheuri and the Six-Rowed Mansury were ripe and harvested on July 30th. All of the varieties were practically free from rust.

Table IV gives the data and yield for the different varieties:

TABLE IV.—VARIETIES OF BARLEY.

Variety	Where From	Days Maturing	Length of Straw—In.	Length of Head—In.	No. Rows Per Head	Length of Beard—In.	Size of Berry	Color of Berry	Wt. Per Bu.—Lbs.	Yield Per Acre—Bu.
McEvan's Hulless	North Dakota Experiment Station	86	21	3½	2	3¼	Very large	Brown	55	21.14
Manscheuri	North Dakota Experiment Station	86	28	3	6	3½	Medium	Yellow	43	22.14
Two-rowed Mansury	North Dakota Experiment Station	93	24	2½	2	3	Large	Yellow	45	22.51
Six-rowed Mansury	North Dakota Experiment Station	86	30	3	6	3	Medium	Yellow	44	24.59

While there was no marked difference in the yield of the different sorts, the Six-Rowed Mansury appeared to lead in productiveness and length of straw, and showed a more healthful growth than did the other varieties.

VARIETIES OF MILLET.

Five varieties of millet were grown in this trial. The land was plowed on May 14th and harrowed twice immediately afterward. On May 29th the ground was again harrowed, and the varieties of millet were sown with a Monitor shoe drill regulated to sow one-half bushel of seed per acre of the smaller kinds. The New Japanese strains were sown at the rate of three pecks per acre, the Red Veronezh at the rate of four pecks per acre. The ground was very dry at the time the millet was sown. Continuous dry weather after the millet was sown caused it to make a very poor stand. A vigorous growth of Russian thistles and other weeds seriously damaged the crop.

Table V gives the data and comparative yields of the different varieties:

TABLE V.—VARIETIES OF MILLET.

Variety	Where From	Height of Straw—In.	Length of Head—In.	Kind of Head	Yield of Fodder in Tons Per Acre
New Japanese	Northrup, King & Co	32	*	Cocksfoot	1.96
Red Veronezh	Northrup, King & Co	42	*	Brome	3.39
Early Fortune	Northrup, King & Co	28	6	Close brome	1.96
German millet	Northrup, King & Co	24	*	Foxtail	2.50
Siberian	Northrup, King & Co	24	2½	Foxtail	2.30

* Did not head out.

The season of 1903 proved to be very adverse to the growth of millet. Light frosts occurred on July 29th and 30th which injured the crop badly, and especially that which was sown on low ground. Early Fortune was the only variety to ripen its seed. This variety was harvested with a binder September 12th. The other varieties were killed before the stage of maturity by a frost on September 14th, at which time they were cut for hay.

The Siberian and German varieties were fine stemmed and leafy in character and made an excellent quality of hay. New Japanese and Red Veronezh were coarse and harsh. Of the list of varieties grown, the Siberian and German seem to lead in the production of fine leafy hay of a quality most suitable for feeding to live stock.

VARIETIES OF CORN.

Nine varieties of corn were grown on the trial plots in 1903. The land had grown a crop of wheat in 1902, and was spring plowed four inches deep and harrowed three times before planting. On June 2d the seed was planted in hills three and one-half feet apart each way. A hand planter, regulated to drop from two to four kernels in a hill, was used in the trial. The thorough harrowing of the ground just previous to planting the corn effectually destroyed a crop of weeds and simplified the matter of subsequent cultivation to a great extent. On account of the cold spring, the corn was slow in coming up.

The corn received the following cultivation:

June 3d, harrowed once immediately after planting.

June 17th, harrowed over with a common peg-tooth harrow.

June 22d, cultivated with a Deere six-shovel cultivator.

June 30th, cultivated with a Deere six-shovel cultivator.

July 10th, cultivated with a Deer surface (blades) cultivator.

July 20th, cultivated with a Deere surface (blades) cultivator.

The corn was greatly retarded in growth during the early part of the season by cold weather and a lack of moisture. Heavy rains later in the season stimulated growth to such an extent that the corn was immature when killing frost occurred on September 14th. Owing to the immature state of the corn and a lack of scales, accurate results could not be obtained, and no weighed yields of fodder or ears were recorded. An estimate, however, was made at the time of cutting and the yields for the smaller varieties were placed at one and one-half to two tons and that of the larger kinds at from two to three tons of fodder per acre.

Table VI gives the data and yield of the different varieties of corn:

TABLE VI.—VARI ETIES OF CORN.

Variety	Class	Where From	Stand	Stage of Maturity at Frost	Av. No. Stalks Per Hill	Height of Stalks—Feet
Will's Dakota	Flint	Oscar H. Will & Co., Bismarck, N. D.	Good	Dough to hard	2 to 3	3½
Northwestern Dent	Dent	Oscar H. Will & Co., Bismarck, N. D.	Good	Dough to hard	2 to 3	4½
Acme Fodder	Dent	Oscar H. Will & Co., Bismarck, N. D.	Good	Milk to dough	2 to 4	3½
Gehu	Flint	Oscar H. Will & Co., Bismarck, N. D.	Good	Dough to hard	2 to 3	3½
Mercer	Flint	Northrup, King & Co	Good	Milk to dough	2 to 3	4½
N. K. & Co.'s Triumph	Flint	Northrup, King & Co	Good	Milk to dough	1 to 3	5½
Pride of the North	Dent	Northrup, King & Co	Good	Kernels just forming.	1 to 3	6
University	Dent	Northrup, King & Co	Fair	Kernels just forming.	1 to 3	6½
Minnesota King	Dent	Northrup, King & Co	Good	Milk to dough	2 to 3	4½
Sorghum	Early amber	Northrup, King & Co	Good	20 per ct. headed out	2 to 6	5

It will be noticed that the Pride of the North, Triumph and University produced the greatest height of stalks. This fact should be kept in mind when choosing a variety for a fodder crop, as a corn binder can be used to much greater advantage in harvesting the large sorts than it can in securing the smaller varieties. The Northwestern Dent, Mercer and Minnesota King come next in order in height of stalks.

Considerable difficulty was experienced in cutting some of the earlier small growing varieties with a corn binder, as their habit of growth placed the ears very close to the ground and it was impossible to set the machine low enough to save them.

Sorghum.—A few rows of sorghum or sugar cane were given a trial at the Station. The same methods of preparation of soil, planting in hills, etc., were followed as have been described for the varieties of corn. The sorghum was planted by hand at the rate of four to six seeds per hill. The light frosts which occurred on July 29th and 30th injured the sorghum to a considerable extent, but it recovered at a later period and produced a fodder very leafy in character and fine in quality. The sorghum was killed by frost on September 14th before reaching maturity. About 20 per cent of it was headed at that time. Strong fall winds stripped the hilled corn of its blades, but did not seem to affect the sorghum much. In this limited trial the sorghum has shown its strong drouth resisting qualities, which indicate that it has a probable value as a fodder crop for the portion of North Dakota represented by the Edgeley Station.

ACKNOWLEDGMENTS.

Mr. B. N. Stone, a member of the board of directors of the Agricultural College, deserves much credit for the valuable assistance he has given in the work of equipping the Station.

Hon. C. H. Sheils and other merchants of Edgeley have aided in a material way by supplying the Station with needful machinery at a very reasonable price. They have also shown their appreciation of the work by the keen interest manifested and the encouragement given to those in charge.

Mr. J. M. Plott has given valuable assistance in many ways by supplying machinery, furnishing boarding for the farm help, stable room, etc.

Respectfully submitted,

O. A. THOMPSON,
Superintendent.

J. H. SHEPPERD,
Vice-Director.

DEPARTMENT OF HORTICULTURE.

To J. H. Worst, Director:

The work in the Horticultural Department for 1903 was the same as for previous years, except that a more extended trial with small fruits and experimental tree planting, to determine the best arrangement and distance of planting for the several species, was started both at Fargo and at Edgeley.

At Edgeley three acres were planted, using elm, silver maple, white ash and box elder. These were all planted two by eight feet apart, using as many box elder as of all the other trees together, and as many silver maple as of both ash and elm, of which an equal number was used.

The trees planted earliest in the spring made much the best start, but the growth of all was fairly good. They were all kept cultivated during May and June, when a block was set aside and mulched with straw as a further experiment.

In addition to this planting, in which all the trees were seedlings, a limited number of Carolina poplars, basswood and Black Hills spruce were planted for ornamental purposes.

The further planting at Edgeley was of several varieties of apples, plums, raspberries, currants and gooseberries, as well as of several ornamental plants. These included the lilacs, spineas, barberry, snowball, peonies, etc. As a rule the stock made a very satisfactory growth for the first year.

The planting at that station should be largely extended the coming season, to determine as rapidly as possible the varieties and methods best adapted to a region where tree growing is sure to prove more difficult than where our previous trials have been made.

In the tree plantation at Fargo the same varieties were used as at Edgeley, but with a slightly different arrangement.

The seedlings planted in 1902 were badly killed during the past winter. The box elders suffered the most, but few being alive in the spring. This was probably due to too rapid a growth the first season, due to the heavy, late summer rains. They probably would have done better if the land had been seeded to oats late in July. These would have dried out the soil and checked the growth of the trees.

The white ash grove shown in the cut received no cultivation except once early in the spring. While the trees have made a very good growth, many of them being twenty-five feet high at the end of twelve years, yet this grove would be much better if it were partly made up of elm and silver maple.

The ash is slow to leave out in the spring and sheds its foliage early in the fall. This allows enough light in the grove in spring and fall to encourage the growth of foxtail and other weeds to some extent.

The silver maple makes so dense a shade throughout the entire season that the weeds and grass cannot get started. In the shelter belts it is proving itself to be the best tree we have. After the first few years its growth is very rapid, and so heavy and dense that it affords the best possible shelter.

The red cedars planted in 1902 practically all lived, none of them winter killing. They made a fine growth of nearly a foot in 1903, showing that in some seasons they are hardier than some of our standard deciduous trees.

As they grow wild by the thousand in the western part of the state, it is fair to suppose that they will succeed wherever they are properly planted and cared for.

THE PLUM ORCHARD.

The winter of 1902 and 1903 killed a large part of the young plum trees that were just coming into bearing. This was probably due to the wet weather in August and September, on which account they did not have an opportunity to properly ripen their wood. This shows the necessity of a cover crop in seasons of excessive rainfall. The remaining trees were so badly blown over by the heavy fall winds, coming when the ground was very wet, that they were all removed to a place affording better protection. It was the first time that fall planting has been attempted with us to any extent, and this experiment will be carefully noted.

APPLES.

The apple trees were injured less by the winter than the plums, and much less than the box elders. Five varieties fruited. The Lyman's Prolific and the Hibernal present the best appearance at the present time. Both of these varieties fruited. About 150 trees were taken from the nursery now and planted in the orchard last fall. A part of them were set in clover sod, and these trees will be cultivated or mulched for a small space about each tree as a comparison with the portion of the orchard where the entire surface will be kept cultivated.

STRAWBERRIES.

In the trial bed of strawberries thirty-five kinds were tried and records kept of each. In the large bed the best varieties are grown, and here trials were made of the different times of planting and, incidentally, of the effects of mulching compared with cultivation.

Another bed is being allowed to stand for a series of years to see how long it will continue profitable. As no rain fell to wet the soil

from the time the plants blossomed until the fruit was harvested, the season was a trying one, but the crop was far from a failure. When the mulch was allowed to lie about the plants, the soil remained mellow and moist, and the lack of rainfall was hardly apparent.

Plants set as late as September made a good growth and produced some fruit last season, though not as much as was expected. It is probably not advisable to set plants at that season unless one has the plants at hand and the season is very favorable.

The old bed produced its third crop last season, and considering the season did remarkably well.

In the trial bed the Warfield gave the heaviest yield, followed in order by the Tennessee Prolific, Emperor, Senator Dunlap, Sample, Wm. Belt, Beder Wood, Drouth King and New York. Several other varieties did nearly as well.

The success of strawberry culture, aside from planting hardy and prolific varieties, depends upon protecting the beds from the south winds and in keeping the soil mellow and moist by cultivating well after the fruit is gathered, and keeping it covered with straw during the blossoming and fruiting season. The plants must not be allowed to become too thick where the moisture is deficient.

CURRANTS AND GOOSEBERRIES.

So much assistance was given by the public in harvesting this fruit that no record was kept. The London Market is easily the most productive and satisfactory of all the currants that we have tried.

RASPBERRIES.

The location of the raspbery bed is not favorable, the soil being too heavy and poorly drained. The Cardinal and Colorado Ironclad were the only ones making at all a favorable showing.

ASPARAGUS.

In 1902 measures were adopted to check if possible the asparagus rust, that was so bad that season as to threaten the complete destruction of the plants.

The upper portion of the plants was all killed in August. At that time they were cut down and the bed was covered heavily with straw. The wet weather caused the straw to rot, with the result that the rust spores were practically all destroyed. In the season of 1903 no rust showed till very late in the season. It then put in its appearance at one end of the bed, and may have been introduced from some outside source. It was noticed that beds which were not covered with straw began rusting very badly, the portion of the plants above ground being killed in July and August. The same treatment was applied at the close of last season. Two new varieties, supposed to be more or less immune to the rust, were also planted. They showed no sign of rusting the first season.

VEGETABLES.

About two acres of vegetables were grown, chiefly to make a demonstration for the benefit of visitors. As in previous seasons, selections were made with a view to improving sweet corn, tomatoes and melons, particularly in the matter of earliness.

EQUIPMENT.

For the purposes of instruction as well as for experiment the Department should be equipped with larger greenhouses and with demonstration rooms. Most of the instruction to students is given in winter, and without means to illustrate the different processes, such as transplanting, pruning, grafting, cross fertilizing, etc., the work is necessarily without the interest and practical value that it should have. As the state becomes settled and homes are improved, the demand for this kind of instruction is rapidly becoming more imperative, and should be met as soon as possible.

BULLETINS.

Bulletin No. 59, devoted to the general subject of tree and fruit culture, has been prepared and is being sent out for the season of 1904.

Respectfully submitted,

C. B. WALDRON.

VETERINARY DEPARTMENT.

J. H. Worst, LL.D., Director:

SIR: During the short space of time since a Veterinary Department has been added to the Experiment Station, its work has principally consisted in making such field and laboratory observations on the various live stock diseases of the state as may be used as a base for lines of experimental work whenever the Department will be provided with the equipments necessary for such a task.

While this work covered almost anything that presented itself, a number of facts have been gathered, which although disconnected, will prove of considerable value when more sharply defined research work can be begun.

Some active work, however, has been done.

The existence of a parasitic skin disease, known as scab or scabies, among the Station cattle made vigorous means of eradication necessary.

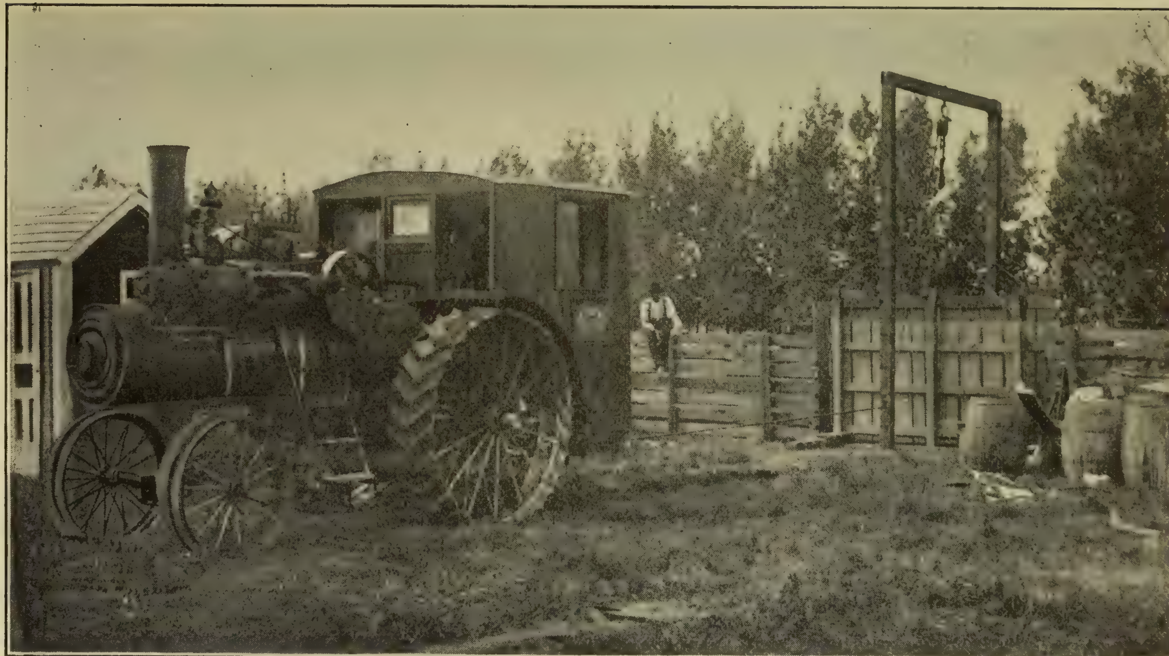
As the conditions under which cattle are kept on the Station are in a large degree similar to those which prevail on ordinary farms, it was deemed wise to take advantage of our misfortune in order to devise a method of scab eradication which could be profitably employed by those engaged in the cattle industry on a small scale.

The only method of treating or eradicating scab which is recognized as efficient by competent observers is the one known as dipping. This consists of the total immersion of the affected animal in a solution of the parasiticide to be employed.

While this mode of treatment is essentially the same as that employed in the eradication of a similar disease of sheep, it is needless to say that in the case of cattle special apparatus is required, as the great weight and size makes the manipulation by hand impossible.

Two types of dipping apparatus are in use. In one, used for dipping large herds, the animals are driven through the vat in which the solution is contained. The vat is sunk in the ground, and is provided with a slide or trap by which the animals are plunged into the solution, and an incline at the exit in order to enable them to walk out of the tank.

The second type is especially designed for dipping on a smaller scale, and consists of a small vat, also sunk in the ground, a movable cage for the animal and a derrick by which the cage is lowered or raised into or out of the tank. An excellent description of such an outfit is found in B. A. I. Bulletin No. 40. The dipping plant mentioned in this bulletin is a stationary structure, and is admirably



Dipping Apparatus—Engine and Tank

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adapted for work on a small or medium scale. Its stationary character, while not a serious disadvantage, has a tendency to limit its usefulness.

While the opportunity presented itself, and while the Station was compelled to dip its cattle, an experiment was carried on with a view to ascertaining if a dipping outfit could be made which could be readily transported.

It was not found difficult to construct the derrick and the cage in such a manner as to allow them to be easily taken apart. In the tank proper this could not be easily accomplished, as the fact of it having to be watertight is not compatible with temporary structure. Furthermore, if the transportable tank could be constructed, such an apparaus would always be bulky and apt to be injured when taken out of the ground and during transportation.

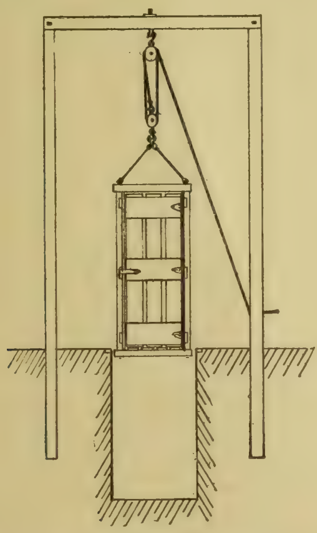

Fig. 4. Derrick, block and tackle and cage.

For the reasons mentioned a tank was tried made of canvas, and it was found that wherever the use of a movable tank is indicated that this material offers special advantages.

The tank used in this experiment was made by Messrs. Beck and Wright, of Moorhead, Minn., under the direction of this Department, at a cost of $15. It proved to be perfectly watertight, and was in no way injured by the dipping fluid used (Formula No. 3, South African lime and sulphur dip).

Before deciding on canvas as a material for the construction of a dipping vat, the effects of the lime and sulphur compound on the fabric were studied by laboratory experiments. Various samples of canvas were boiled for several hours in the nonsedimented lime and sulphur mixture, and no injurious results could be noticed.

It was hoped that the tank could be lowered in an accurately dug pit without any further preparation. This, however, was not possible owing to the caving of the soil in this section of the state, and it was necessary to provide the excavation with curbing. For this purpose some old lumber was used, such as may be found on almost any farm yard.

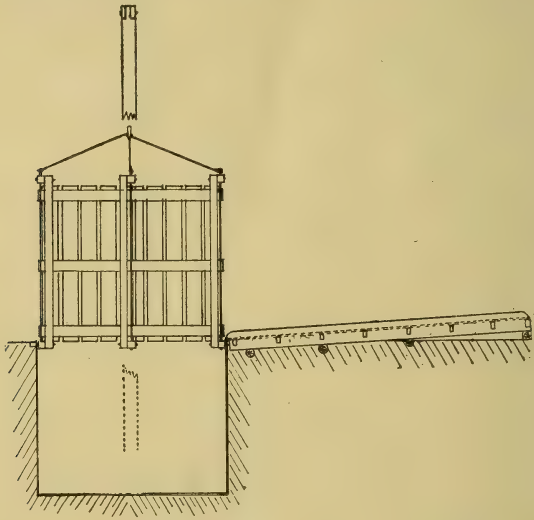

Fig. 5. Side view of cage, derrick, tank and dripping floor.

Considering the nature of the soil in the higher portions of the state, the writer feels quite certain that curbing will not always be necessary. This opinion, however, is not based upon actual observation.

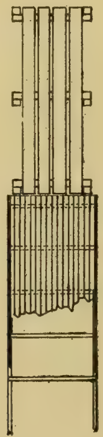

Fig. 6. Construction of cage floor and dripping floor.

Dipping Tank, Animal in Tank

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The canvas bag is lowered into the pit, and its walls kept upright and smooth by lacing its upper edge to a two by four placed around the pit in the manner shown in Fig. 3.

After the tank was used, it was cleaned and permitted to dry, when it was rolled up and stored by hanging it to a rafter in a barn so that it may not be injured by rodents.

The cage, derrick and the combined guiding slide and stop were so constructed that by loosening a few bolts they could be easily taken apart.

The dripping floor can be moved without being taken to pieces. (For construction see illustrations.)

For the approaches rough fencing was used, such as is commonly used on farms for the construction of corrals, etc.

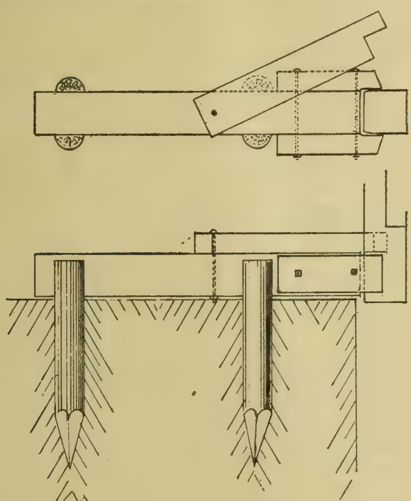


Fig. 7. Construction of guiding slide and brake.

The cost of the construction of this transportable dipping plant was as follows:

Lumber	$25.51
Hardware	7.01
Block, tackle and rope	6.60
Canvas tank	15.00
Labor	13.50
Total	$67.12

The cost of the dipping fluid is about $14 per vat, and this will be amply sufficient for one day's dipping. During our experiments it was estimated that 150 head of cattle could be dipped in one day.

While the opportunity presented itself some observations were made on the effect of lime and sulphur dip on the quality of the wool of sheep, and for this reason the Station flock was dipped twice

during the spring and once during the fall. The first dipping took place shortly after shearing, and the last one when the fleece was about one and a half inches in thickness.

After the last dipping samples of the wool were taken. In order to obtain expert opinion on the samples, one was sent to the Bureau of Animal Industry, Washington, D. C., by which it was referred to a New England wool expert. Another was submitted to the North Star Woolen Mills of Minneapolis. The following replies were received:

MINNEAPOLIS, Minn., January 18, 1904.

Prof. L. Van Es, North Dakota Agricultural College:

DEAR SIR: We acknowledge receipt of your favor of the 13th inst., also sample of wool. This wool is of good character and well bred. We cannot notice any bad effects from being dipped. The wool washes out white, but is a little harsh, which is the only fault we could find, and this is not serious. The sample shows more strength of fibre than the average lots received by us. We shall be pleased to give you any further information, if desired.

Yours truly,

NORTH STAR WOOLEN MILL CO.

(Signed) PARK W. PECK,

Treasurer.

BUREAU OF ANIMAL INDUSTRY,

WASHINGTON, D. C., January 29, 1904.

Prof. L. Van Es, Agricultural College, N. D.:

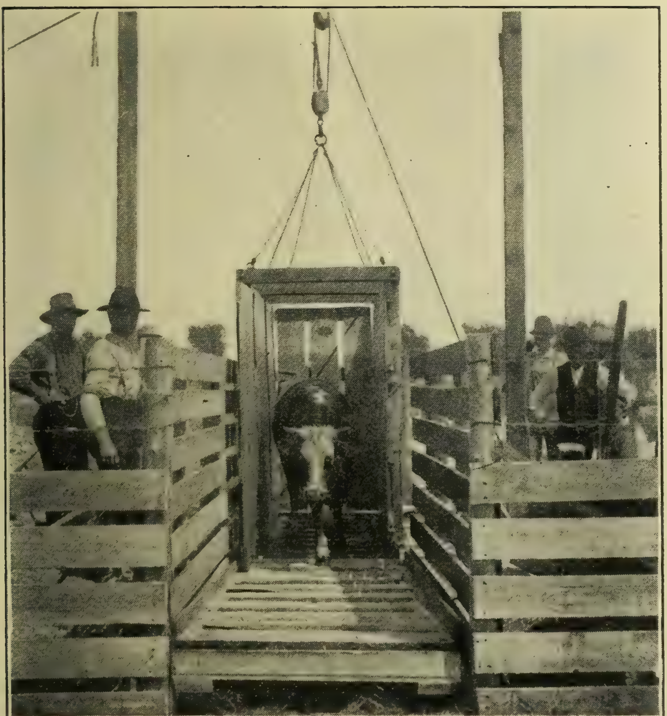
DEAR SIR: In accordance with my letter to you of the 21st inst., I now have some data from New England with reference to the sample of wool which you sent to this Bureau, and which was forwarded to a leading manufacturer of wool fabrics at Sanford, Me. The expert there reports that, so far as he was able to determine with the naked eye, the dip had not injured the fibre in any way. He states that at first sight he thought perhaps it showed a little tenderness near the point, but after going into the matter further and comparing it with undipped wools in stock, he reported that he could not see that it showed any less strength than wools which have not been dipped at all. The gentleman who had the sample in charge, with the desire to have corroborative judgment, took the wool to Boston and placed it in the hands of a gentleman whom he reports as an expert of first rank. After examination, this expert says "he could not see that the dip had injured the fibre at all." When asked if he did not think the top end of the fibre was not as strong as the other end, he replied that all wools show less strength at this end than at the base. He considered "the wool all right in every way." The names of these experts are not in my possession, but I am assured that they have the entire confidence of the wool manufacturers of New England, and it is one of these manufacturers who has kindly given this information for this letter.

Respectfully

(Signed) D. E. SALMON,

Chief of Bureau.

From the letters quoted above it seems that lime and sulphur dip does not injure the wool, as has been frequently stated by those who are interested in the manufacture and sale of patent dips.



Dipping Tank, After Dipping

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The dip used was the same as is recommended for cattle, and contains a larger proportion of lime than the lime and sulphur dip designed for sheep. It is therefore quite reasonable to presume that if the stronger cattle dip does not injure the wool, wool growers have nothing to fear from the use of the lime and sulphur sheep dip.

Co-operating with Prof. L. R. Waldron, Assistant Botanist, some experiments were made with a view of studying the effects of the ingestion of *Zygadenus elegans* on animals. Some cases of stock poisoning have occurred in the eastern portion of the state in which there was good reason to suspect this plant.

As only a small quantity of the plant could be obtained when the work could be done, no definite results were obtained. The intention, however, is to continue this line of work during the coming summer.

The experiments made thus far included feeding and hypodermic injection of substances obtained by the Stass-Otto alkaloid extraction method. Rabbits were used in those preliminary experiments. The following observations were made:

Rabbit No. 1. Five grams of the bulb were offered at 10 a. m. At 12 m. 0.5 grams was eaten. At 1.30 p m. the whole quantity was consumed, but with reluctance. The rabbit was watched until 6 p. m., but no toxic symptoms made their appearance.

Rabbit No. 2. Forty grams of dried plants were offered and consumed in two hours. No effect followed the eating of the plants.

Rabbit No. 3. Received hypodermatically 0.04 grams of substance extracted with chloroform, but did not suffer any bad effects.

Rabbit No. 4. Received subcutaneously 0.03 grams of substance obtained by ether extraction of alkaline extract of plant. Injection made at 3 p. m. At 3:30 slight inco-ordination of movements was noticed. At 3:45 the same is continued, and when the animal is excited by blowing upon it, it has a slight convulsion. At 4:30 the rabbit fell upon its back and is not able to resume the normal posture without aid. The intoxication is very marked. At 5:30 the rabbit it very stupid and its breathing shallow. The following morning the animal is apparently very sick, and at 2 p. m. it died. Weight of rabbit, 490 grams.

The lesions shown on post mortem are such that death by sepsis was not improbable. The symptoms of the preceding day were undoubtedly due to the injection of the toxic material.

Rabbit No. 5. Received hypodermatically 0.01 grams of substance obtained by chloroform extraction of acidulated extract of plants. Some transitory dullness resulted, but in three hours the rabbit was apparently all right.

Rabbit No. 6. Subcutaneous injection of 0.02 grams of material obtained by ether extraction of acidulated extract of plant. This

caused the animal to droop in the corner of its cage for a few hours, but produced no results otherwise.

Rabbit No. 7. Ten c. c. of watery extract were introduced into the stomach by means of a rubber tube. No toxic effects developed.

Rabbit No. 8. Fifteen c. c. were given in the same manner as in No. 7. No evidence of poisoning was observed.

Effort will be made to continue these experiments, not only on rabbits, but also on cattle and sheep, during the coming season. The wide distribution of this plant certainly is warrant for endeavoring to gain some definite knowledge on this subject.

While the extent of the live stock industry of the state seems to warrant the undertaking of research work on animal disease, this Department has not been able to do much in this direction, owing to lack of proper equipment. Our laboratory facilities are very limited, only one small room being set aside for this purpose, and as this space was not designed for use as a laboratory, considerable annoyance and inconvenience is experienced.

The laboratory is only provided with the most essential apparatus, and of this a large part is private property. For the necessary laboratory animals a small closed shed is used, and when during inoculation experiments animals are to be kept under constant observation, the cages have to be taken in the laboratory room, where they are certainly not conducive to a healthy atmosphere or to the cleanliness so essential in places where virulent bacteria are being handled.

The lack of a special stable and post mortem room for farm animals is greatly felt. If such a place were available, diseased animals could be kept under continued observation for clinical study, or autopsies could be held close to the laboratory, which is an almost imperative feature when carrying on research work.

Such work is at present out of the question, as it would be hazardous to bring diseased animals to the station stables where valuable animals are being kept for other purposes.

Among the investigations which seem to merit attention there may be mentioned a study on the live history of the scab mite and its resistance to the various acaricides now in use, along with experiments in improving the present methods of scab eradication. For such work it would be necessary to keep scabby animals the year around, and without special equipment this would be highly detrimental to our high bred farm animals.

Tape worm disease in sheep also deserves our most earnest attention. Losses are continually sustained through the infestment by *Taenia fimbriata,* and while some general rules for prevention may be formulated, intelligent eradication is not possible as long as the life history of this parasite is not understood. It seems that the interests of our wool and mutton growers are of such a proportion as to warrant the beginning of some investigation in this direction.

A peculiar anaemia of the horse known as swamp fever offers a field for investigation, and deserves attention from a practical as well as a purely scientific standpoint.

Besides those investigations, immunization experiments may be conducted in relation to hemorrhagic septicaemia, tuberculosis, glanders and other communicable diseases occurring in North Dakota.

The Department library has been neglected for years, and is poor in works of reference bearing on animal disease, general pathology, bacteriology and laboratory technique. There are absolutely no files of the current literature on these subjects, but the writer is glad to state that during the past year some very important periodicals have been added to the library.

Permit me to close with the recommendation that the Veterinary Department be provided with the necessary building and equipments in order to carry on experiments and research work on animal diseases to an extent commensurate with the ever increasing live stock interests of the state.

Respectfully submitted,

L. VAN ES,

Veterinarian.

REPORT OF THE FOOD COMMISSIONER.

To J. H. Worst, Director:

SIR: I herewith submit my First Annual Report as Food Commissioner for North Dakota, covering the period of six months since my appointment at the time the law went into effect, July 1, 1903.

The eighth session of the legislative assembly enacted a pure food law, and charged the Experiment Station with the enforcement of the law, and designated the chemist of the North Dakota Government Agricultural Experiment Station as the official chemist for analyzing foods and beverages offered for sale in the state. The board of trustees of the Experiment Station, at the regular monthly meeting, April 8, 1903, passed the following resolutions:

"WHEREAS, The eighth legislative assembly of North Dakota having passed senate bill No. 26, providing for the inspection and analysis of foods, and making it the duty of the North Dakota Government Agricultural Experiment Station to inspect and analyze such foods; therefore be it

Resolved, That the board appoint the chemist of the Experiment Station, Professor E. F. Ladd, as food commissioner to have charge of the work, and that he be authorized and empowered to execute the requirements imposed upon the Experiment Station by said act, the expenditure therefor being limited to the amount appropriated by the state for such purpose."

With an annual appropriation of only $1,500, it was necessary that the work be done systematically or but little could possibly be accomplished with the available funds.

A study of the law as enacted convinced me that three guiding principles are laid down in the law, namely:

1st. Harmful chemical preservatives are not to be used in food products or beverages.

2d. Harmful coloring matters, or coloring matters which would deceive or tend to deceive the purchaser with regard to the character of the goods, are considered as adulterants and their use prohibited.

3d. All food products and beverages shall be labeled true to name, and the substitution of cheaper or inferior products is considered as adulterants.

Under this interpretation of the law our duty seemed fairly clear, and to successfully enforce the law I have felt that the prosecution of the retail merchants, who are not always in a position to tell when food products are adulterated, would not be found the most satisfactory way of correcting the existing evil. The source of supply

needs first of all to be purified, and then there remains but little to do but to guard the consumer and see that the standard of purity is maintained, and to look after the few manufacturers who by nature are not honest, or the local retailers, few in number though they be, who are willing to sacrifice the health of their customers for the few extra dollars to be secured in handling inferior and adulterated products.

Proceeding on this line, we placed the matter before the wholesalers and manufacturers, informing them of our interpretation of the law, and telling them what we expected in the way of improvements in the food products to be offered for sale in this state.

We pointed out the fact that North Dakota had in the past been a "dumping ground" for adulterated goods and beverages; that the new law was stringent, and that the amount of publicity to be given the manufacturers of adulterated goods would react most disastrously for those who failed to comply with its requirements. I am pleased to say that, with three or four notable exceptions, all of the large foreign houses doing business in the state at once manifested a desire to have their goods in shape to meet the approval of the department. I feel that in this way we have accomplished more in the first six months for improving the purity of foods than could possibly have been accomplished in two years' time by any indiscriminate prosecution of retailers found violating the law, and this at much less expense to the state and without serious disturbance to business.

I count not the success by the number of prosecutions and convictions secured, but rather by the number of products turned back from the state, and the showing of purity for the goods now found in the state. Much still remains to be done, and many well known lines of foods are still found to be adulterated, but I have preferred to concentrate the work upon a few of the most important lines and then gradually extend this to include others during the coming year.

NOTICEABLE CHANGES

The cheap jellies, jams, preserves, etc., made from waste apple products are no longer labeled and sold as currant, strawberry, etc., but are clearly labeled and sold as "Fruit Jelly," etc., and no longer contain preservatives and coal tar dyes. One year ago our report showed that 100 per cent of the jellies, jams and preserves were, under our law, adulterated; today we find but a small per cent in violation of the law.

Where sulphites were used in nearly all grades of corn and succotash, we find only rarely the product offered for sale in the state. Saccharin was found in the majority of canned corns, beans, peas and fruits, but at the present time is not generally employed, and the few who continue its use are generally labeling the goods to show its presence. Benzoic acid and salicylic acid are still too frequently employed in preserved goods.

EXTRACTS AND FLAVORS.

One year ago, so far as I have been able to find out, there were but two brands of extracts sold in North Dakota always what they were represented to be. The great majority of extracts of lemon and vanilla were artificial products of little value, not infrequently colored with coal tar dye and with little of merit to recommend them. Today these have been largely driven from the state or are so labeled that the public know what they contain. Some of the best lemon extracts are now sold without color, being water white, and the consumer should bear in mind that color is no indication that a product is to be preferred, for often color is used to cover up a fault.

VINEGARS.

One year ago a pure cider vinegar could hardly be found in the state. While there are sold spirit vinegars today, they must be so labeled, and the number of pure cider vinegars have largely increased. That a different line of goods was sold in this state from that offered in Minnesota is clearly shown in the case of vinegars. There are firms whose vinegars have been repeatedly tested in Minnesota, and the published records show them to have been cider vinegars, and yet in this state nothing but spirit vinegars were sold by the same firm, although the label distinctly guarantees the vinegar to be pure apple cider vinegar. Competition they claimed forced them to substitute the cheaper product for the genuine. The prices at which they were being sold do not always warrant this absurd assumption.

CANNED GOODS.

Sulphites were common in corn, as also was saccharin. The corn was largely bleached by means of sulphites, and the inferior product sweetened with saccharin or so-called coal tar sugar. The pack coming into the market at the present time is nearly free from sulphites, and saccharin, if used at all, is labeled to show its presence. After July 1, 1904, the use of saccharin is prohibited, and I am convinced this will be of advantage to the consumer. Soaked goods have not received the attention they deserve, but other duties of great moment have taken our time, and as soon as these matters are remedied we shall give further attention to these products.

Peas and string beans were also sweetened with saccharin, and in not a few instances chemical preservatives were employed. We have found formaldehyde and borax to be the most common preservative for these products. Saccharin has been found also in several samples of sweet pickles.

MAPLE SYRUPS AND SUGARS.

While several samples have been passed, I have yet to find, on the general market, one which I would class unhesitatingly as genu-

ine maple syrup or sugar. The majority of these products are more than 60 per cent of added cane sugar of the same density. In but few cases have we found these syrups to contain glucose, and in no instance have we found harmful ingredients. Under the North Dakota law, to label them as maple syrup when not made from the sap of the maple tree is misleading and deceiving the public, therefore, an adulteration. After July 1, 1904, these products must be labeled true to name in order to be legally sold in this state.

MEATS AND LARDS.

But little has been done as yet in the examination of meat and meat products. A few samples have been examined, and in two of these coal tar dye was found, also borax and sulphites. Several products used in preparing meat products have been examined and are far from being commendable. Quite a number of samples of canned meats have been analyzed, and in only two or three instances was borax found. Some samples of prepared boneless chicken and turkey used for sandwiches gave evidence of being largely composed of veal, bleached to resemble chicken. Some samples of chipped beef put up in glass contained borax used as a preservative agent. With lard very little has as yet been done in the way of systematic examination.

During the summer of 1904 it is proposed to give some attention to the meats sold in the state.

CANDIES AND CONFECTIONS.

The colored candies have been found to be very generally colored with coal tar dyes of various shades and classes. The most of these dyes have been found to be the so-called aniline or coal tar dyes. Some of the cheap candies have been found to be flavored with synthetic products in violation of the law. Some of the manufacturers of cheap candies have stated that if they had to comply with the law or the force of the same could not be broken they would withdraw from the state. This course would be to the health of the children.

BEVERAGES.

But few beverages have been examined thus far, and it has been found that many of these are wholly artificial products, colored with coal tar dyes, flavored with chemicals and preserved with salicylic acid or benzoic acid. It is believed that a great majority of the beverages—wines, brandies, ciders, cordials, etc.—are in violation of the law and will soon be driven from the market.

BOX CAR MERCHANTS.

During the past fall a large number of transient firms, so-called "box car merchants," flocked to the state at about harvest time

canvassing the country, taking orders for groceries, the goods to be delivered later. In my experience with the goods handled by this class of merchants hardly a product was pure or what it was represented to be. The cider vinegars proved to be cheap spirit vinegars colored. The extracts were illegal and inferior. The coffee purporting to be Mocha and Java contained no Mocha, and was mainly wild African Java, a very inferior product and but little better than chicory. The syrups were usually glucose, colored with coal tar dye and flavored artificially. Unless they bring a better grade of products, they will not be permitted another year to do business in the state.

PUBLICITY.

One commendable feature in the food law of the state is the required publicity in an official way. Nothing will drive wrongdoers to correct evils more quickly than publicity. Let the public know that this or that manufacturer's good are not pure but adulterated, and the discriminating public will refuse to purchase and the retailers no longer find it profitable to handle the products.

THE PRESS AND PUBLIC SENTIMENT.

The press of the state have unanimously supported the work of the department, and have done much to aid in creating a healthy public sentiment and keep the public informed of the character of the adulteration being practiced in food products sold in the state, and the aid given by the women's unions of federal clubs brought the matter directly before the people in the homes, thus forcing careless manufacturers to see that their goods would stand the test of purity.

PROSECUTIONS.

But few prosecutions have been necessary, and it is believed that the most of the work can be successfully accomplished without resorting to a large number of prosecutions. At all times a few court cases will be necessary, first, to keep a certain class of manufacturers, jobbers and retailers in line, and, second, to warn others of danger when they become careless.

Analyses of food products coming into the state and notices to the wholesalers have resulted in turning back whole car lots of goods coming into the state. Eastern manufacturers have visited the state and gathered up products formerly sold and removed them from the state. Other houses have requested merchants having certain lines of their goods to return them to be replaced with goods known to be in compliance with the law. Merchants have, to my personal knowledge, returned promptly to the jobbers goods found to be in noncompliance with the law.

SUBSTITUTIONS.

Syrups formerly labeled as sorghum are now labeled as glucose or as corn syrup or go under some coined name with the per cent of the several syrups making up the blend clearly indicated on the label. This is a commendable course and is as it should be. Glucose or corn syrup, properly made, free from acids, as it is at the present time, is a desirable food product, and should be sold for what it is and the public given to understand that the product is a natural food product. Sell it on its own merits and create a demand for it, and not have it masquerading under a false name and the public deceived. The same may be said of well prepared cotton seed oil as a salad oil, now generally sold falsely labeled as olive oil. Such a course is in direct violation of the law. Goods labeled as being put up in England, France, Germany, Italy or Spain are not uncommon, and in some cases it is known that they are put up in Chicago, New York or Philadelphia. Goods are so labeled for no other purpose than to deceive the consumer, and are, therefore, in violation of the law, and if they are to be sold in this state the labeling should be made to conform with the facts.

Jellies, jams, etc., made from the waste products of apples were formerly largely colored with coal tar dyes, flavored with artificial chemical flavor and then labeled and sold for strawberry, currant, raspberry, plum, etc. Such products are still on the market minus the coal tar dye, but are labeled and sold simply as "Fruit Jelly" or "Apple Jelly," and the public know what they are buying. There are still too many jellies sold as strawberry, currant and raspberry not composed wholly of these fruits, and we hope to see these largely corrected during the present year.

A few manufacturers, whose reputation for pure goods of high grade is not particularly enviable, have withdrawn from doing business in this state, much to my satisfaction and to the welfare and health of the rising generation. A few others will possibly do likewise, but in most cases the manufacturers are changing the goods or the labeling to comply with the law.

The amount of work has been far in excess of anything we had anticipated. The large influx of box car merchants had not been anticipated. Largely driven from Minnesota, when their goods would not stand the test of the pure food law, they came to North Dakota and did a large business. For the coming year a large amount of field work will be necessary to hold this class of goods in check. and to prevent the people from being imposed upon. We had not anticipated such strenuous or general opposition from manufacturers of adulterated goods, including those who supply the public with chemical preservatives, coal tar dye and saccharin. These parties have flooded the state with literature derogatory of the work being done for the protection of the public. That the chemical preservatives are unnecessary and may often prove injurious to health has

been repeatedly pointed out by others, and I have presented some of the reasons against their use in Bulletins Nos. 53 and 57. In Bulletin No. 53 we discussed the use of coal tar dye in food products. Even though not all of these dyes are harmful, is there any gain to the public in permitting these products to be employed in foods? Does it not permit of the grossest kind of practice when there is any desire to cover up fraud? It cannot be said that these dyes add anything to the food value. Neither can it be said, used as they have been, that they have always added to the attractiveness of food products.

SOME COMPARISONS.

In the Thirteenth Annual Report of the Experiment Station, page 32, we gave a tabulated statement showing the extent of food adulteration as shown by our analyses. From this table we reproduce the following.

TABLE SHOWING FOOD PRODUCTS EXAMINED IN 1902.

	No. Examined	No. Pure	No. Adulterated	Per Cent Adulterated
Jellies, preserves, etc.	33	0	33	100
Catsups, bottled	8	0	8	100
Canned corn and succotash	9	1	8	88
Canned peas	12	6	6	50
Canned tomatoes	10	6	4	40
Lemon extracts	10	3	7	70
Vanilla extracts	10	3	7	70
Candies	28	14	14	50
Totals and average	120	33	87	72

Comment regarding the above table is unnecessary.

We now reproduce from our records the results of aur analyses for the three months, October, November and December, 1903. In this we have assumed that the samples of canned goods, etc., are from the pack of 1903, but in some instances it is known that old stock was examined.

TABLE SHOWING ANALYSES FOR FOOD PRODUCTS—FALL OF 1903.

	No. Examined	No. Pure	No. Adulterated	Per Cent Adulterated
Jellies, preserves, etc.	96	67	29	30
Catsups, bottled	36	27	9	25
Canned corn and succotash	39	28	11	28
Canned peas	24	15	9	38
Canned tomatoes	24	24	0	0
Lemon extracts	21	11	10	47
Vanilla extracts	10	5	5	50
Candies	42	28	14	33
Totals and average	268	215	87	32

The total number of samples has been much larger than in 1902, but the per cent of adulterated goods has been reduced from 72 to 32 per cent. The most marked change has been found in preserves, jams, jellies, etc. Where one year ago every sample examined was adulterated, now but 30 per cent are found to be illegal. We may add also that the quality has been proportionately improved.

We feel justified in saying that the people of North Dakota are today receiving a class of food products from the groceries which will compare favorably with those sold in our sister states.

Much yet remains to be done, but we feel encouraged at the substantial progress made during the first six months under the new law.

I submit herewith the report of the chemical work completed during the past year.

Respectfully submitted,

E. F. LADD.

CHEMICAL WORK DONE IN 1903.

PRESERVES, JAMS, JELLIES, ETC.—LEGAL.

Lab. No. 68.

Brand, Cal. Yellow Crawford Peaches, University.

Producer or jobber, Winston, Harper, Fisher & Co., Minneapolis.

Retailer, Berg. Bros., Cooperstown.

Lab. No. 82.

Brand, Pure Blackberry Jam, Dinner Party.

Producer or jobber, Orchard Park Canning Co., Orchard Park, New York.

Retailer, Nash Bros., Grand Forks.

Lab. No. 113.
Brand, Strawberry Jam, Our Favorite.
Producer or jobber, Farnham Canning Co., Erie, N. Y.
Retailer, Mr. Grant, Fargo.

Lab. No 117. (Passed.)
Brand, Raspberry Preserves, Griffin's Extra.
Producer or jobber, California Fruit Canners' Association.
Retailer, Mr. Grant, Fargo.

Lab. No. 139. (Passed.)
Brand, Strawberry Preserves, Purity.
Producer or jobber, E. G. Daily & Co., Detroit, Mich.
Retailer, Anthony Kelly & Co. Minneapolis

Lab. No. 217.
Brand, Strawberry Preserves, Purity.
Producer or jobber, E. G. Daily & Co., Detroit, Mich.
Retailer, Anthony Kelly & Co. Minneapolis

Lab. No. 243.
Brand, Strawberry Preserves, Home.
Producer or jobber, Griggs, Cooper & Co., St. Paul.

Lab. No. 244.
Brand, Red Currant Jelly, Home.
Producer or jobber, Griggs, Cooper & Co., St. Paul.

Lab. No. 252.
Brand, Strawberries, Home.
Producer or jobber, Griggs, Cooper & Co., St. Paul.

Lab. No. 253.
Brand, Blackberries, Oval.
Producer or jobber, A. Booth & Co., Baltimore, Md.
Retailer, Griggs, Cooper & Co., St. Paul.

Lab. No. 254.
Brand, Red Cherries, Jack Rose.
Producer or jobber, Fleming & Co., Baltimore, Md.
Retailer, Griggs, Cooper & Co., St. Paul.

Lab. No. 255.
Brand, Grated Pineapple, Gold Seal.
Producer or jobber, A. Booth & Co., Baltimore, Md.
Retailer, Griggs, Cooper & Co., St. Paul.

Lab. No. 256. (Passed.)
Brand, Raspberries, Oval.
Producer or jobber, A. Booth & Co., Baltimore, Md.
Retailer, Griggs, Cooper & Co., St. Paul.

Lab. No. 259.
Brand, Strawberries, Oval.
Producer or jobber, A. Booth & Co., Baltimore, Md.
Retailer, Griggs, Cooper & Co., St. Paul.

Lab. No. 262.
Brand, Grated Pineapple, Florida.
Producer or jobber, A. Booth & Co., Baltimore, Md.
Retailer, Griggs, Cooper & Co., St. Paul.

Lab. No. 263.
Brand, Choice Rhubarb, Aurora.
Producer or jobber, Geneva Preserving Co., Geneva, N. Y.
Retailer, Griggs, Cooper & Co., St. Paul.

Lab. No. 264. (Passed.)
Brand, Pie Peaches, Oval.
Producer or jobber, A. Booth & Co., Baltimore, Md.
Retailer, Griggs, Cooper & Co., St. Paul.

Lab. No. 266.
Brand, Bartlett Pears, Home.
Producer or jobber, Griggs, Cooper & Co., St. Paul.

Lab. No. 267. (Passed.)
Brand, Red Pitted Cherries, Home.
Producer or jobber, Griggs, Cooper & Co., St. Paul.

Lab. No. 270.
Brand, Sliced Peaches for Cream, Bengal.
Producer or jobber, Griggs, Cooper & Co., St. Paul.

Lab. No. 271.
Brand, Bartlett Pears, Vertibull.
Producer or jobber, H. F. Hemingway & Co., Baltimore, Md.

Lab. No. 273. (Passed.)
Brand, Fresh Peaches, First Quality.
Producer or jobber, P. Wheeler & Co., Baltimore, Md.
Retailer, Griggs, Cooper & Co., St. Paul.

Lab. No. 274. (Passed.)
Brand, Apricots, Amazon.
Producer or jobber, Haywards Canning Co., Haywards, Cal.

Lab. No. 275.
Brand, Crawford Peaches, Hesperian.
Producer or jobber, Hunt Bros. Co., Haywards, Cal.

Lab. No. 282.
Brand, Gooseberries, Oval.
Producer or jobber, A. Booth & Co., Baltimore, Md.
Retailer, Griggs, Cooper & Co., St. Paul.

Lab. No. 286.
Brand, White Cherries, Oval.
Producer or jobber, A. Booth & Co., Baltimore, Md.
Retailer, Griggs, Cooper & Co., St. Paul.

Lab. No. 288.
Brand, Red Raspberries, preserves, America.
Producer or jobber, Kidwell Bros. & Co., Baltimore, Md.

Lab. No. 290.
Brand, Gooseberries, Bengal.
Producer or jobber, Griggs, Cooper & Co., St. Paul.

Lab. No. 295.
Brand, Blueberries, Eagle.
Producer or jobber, A. & R. Loggie, Loggieville, N. B., Canada
Retailer, Griggs, Cooper & Co., St. Paul.

Lab. No. 296.
Brand, Preserved Strawberries, Bengal.
Producer or jobber, Griggs, Cooper & Co., St. Paul.

Lab. No. 300. (Passed.)
Brand, Strawberries, Canned.
Producer or jobber, Geo. R. Newell, Minneapolis.

Lab. No. 304.
Brand, Blueberries, Eagle.
Producer or jobber, A. & R. Loggie, Loggieville, N. B., Canada.
Retailer, Griggs, Cooper & Co., St. Paul.

Lab. No. 313. (Passed.)
Brand, White Cherries, Ox Heart, Honey Dew.
Producer or jobber, Erie Preserving Co., Buffalo, N. Y.

Lab. No. 317.
Brand, Red Raspberries, Honey Dew.
Producer or jobber, Erie Preserving Co., Buffalo, N. Y.

Lab. No. 318. (Passed.)
Brand, Red Raspberry Jam, Honey Dew.
Producer or jobber, Erie Preserving Co., Buffalo, N. Y.

Lab. No. 319. (Passed.)
Brand, Pure Strawberry Jam, Honey Dew.
Producer or jobber, Erie Preserving Co., Fenton, N. Y.

Lab. No. 320. (Passed?)
Brand, Black Raspberry Jam, Honey Dew.
Producer or jobber, Erie Preserving Co.

Lab. No. 326.
Brand, Raspberry, Oval.
Producer or jobber, A. Booth & Co., Baltimore, Md.
Retailer, Foley Bros. & Kelly, St. Paul.

Lab. No. 327.
Brand, Blueberries, Eagle.
Producer or jobber, A. & R. Loggie, Loggieville, N. B., Canada.
Retailer, Foley Bros. & Kelly, St. Paul.

Lab. No. 335.
Brand, Extra Strawberries, Flour City.
Producer or jobber, Curtice Bros., Rochester, N. Y.
Retailer, Foley Bros. & Kelly, St. Paul.

Lab. No. 338. (Passed.)
Brand, Gooseberries, Oval.
Producer or jobber, A. Booth & Co., Baltimore, Md.
Retailer, Foley Bros. & Kelly, St. Paul.

Lab. No. 340.
Brand, Blackberries, Extra Standard.
Producer or jobber, Gibb's Preserving Co., Baltimore, Md.
Retailer, Foley Bros. & Kelly, St. Paul.
Lab. No. 343. (Passed.)
Brand, Gooseberries, Ribbon.
Producer or jobber, Geneva, N. Y., company not given.
Lab. No. 345.
Brand, Strawberries, Challenge.
Producer or jobber, H. S. Langfair & Co., Baltimore, Md.
Lab. No. 350.
Brand, Preserved Red Raspberries, Oval.
Producer or jobber, A. Booth & Co., Baltimore, Md.
Retailer, Foley Bros. & Kelly, St. Paul.
Lab. No. 353.
Brand, Sliced Pineapple, No. 5.
Producer or jobber, Foley Bros. & Kelly, St. Paul.
Lab. No. 354.
Brand, Grated Pineapple, No. 6.
Producer or jobber, Foley Bros. & Kelly, St. Paul.
Lab. No. 362.
Brand, Black Raspberries, No. 2.
Producer or jobber, Foley Bros. & Kelly, St. Paul.
Lab. No. 363.
Brand, Preserved Blackberries, No. 3.
Producer or jobber, Foley Bros. & Kelly, St. Paul.
Lab. No. 364.
Brand, Strawberries, No. 1.
Producer or jobber, Foley Bros. & Kelly, St. Paul.
Lab. No. 367.
Brand, Gooseberries, Preserved, No. 4.
Producer or jobber, Foley Bros. & Kelly, St. Paul.
Lab. No. 381. (Passed.)
Brand, Blackberries, Victory.
Producer or jobber, John Boyle Co., Baltimore, Md.
Retailer, Griggs, Cooper & Co., St. Paul.
Lab. No. 382.
Brand, Strawberries, Victory.
Producer or jobber, John Boyle Co., Baltimore, Md.
Retailer, Griggs, Cooper & Co., St. Paul.
Lab. No. 383.
Brand, Grated Pineapple, Florida.
Producer or jobber, A. Booth & Co., Baltimore, Md.
Retailer, Griggs, Cooper & Co., St. Paul.
Lab. No. 384.
Brand, Sliced Pineapple, Florida.
Producer or jobber, A. Booth & Co., Baltimore, Md.
Retailer, Griggs, Cooper & Co., St. Paul.

Lab. No. 385.
Brand, Extra Pineapple, Oval.
Producer or jobber, A. Booth & Co., Baltimore, Md.
Retailer, Griggs, Cooper & Co., St. Paul.

Lab. No. 386.
Brand, Grated Pineapple, Gold Seal.
Producer or jobber, A. Booth & Co., Baltimore, Md.
Retailer, Griggs, Cooper & Co., St. Paul.

Lab. No. 387.
Brand, Blueberries, Home.
Producer or jobber, Griggs, Cooper & Co., St. Paul.

Lab. No. 476.
Brand, Preserved Strawberries, University.
Producer or jobber, Winston, Harper, Fisher & Co., Minneapolis.
Retailer, M. Grange, Sheldon.

Lab. No. 490.
Brand, Preserved Pitted Cherries, Millionaire's Club.
Producer or jobber, Fenton Bros. Co., Fenton, N. Y.
Retailer, H. V. Hicks & Son, Oakes.

Lab. No. 491.
Brand, Red Raspberries, Gertfield.
Producer or jobber, North Collins Preserving Co. North Collins, New York.
Retailer, H. V. Hicks & Son, Oakes.

Lab. No. 500.
Brand, Strawberries, Jewett's High Grade.
Producer or jobber, Jewett Bros, Aberdeen, S. D.
Retailer, Cunningham & Lawrence, LaMoure.

Lab. No. 510.
Brand, Preserved Strawberries, University.
Producer or jobber, Winston, Harper, Fisher & Co., Minneapolis.
Retailer, Hurley Bros., Forman.

Lab. No. 554. (Questionable.)
Brand, Pure Strawberry Jelly, Belmont.
Producer or jobber, Chicago Concentrating Co., Chicago, Ill.
Retailer, Wright-Clarkson Mercantile Co., Duluth, Minn.

Lab. No. 581.
Brand, Strawberry Table Preserves.
Producer or jobber, Curtice Bros.' Co., Rochester, N. Y.
Retailer, M. W. Hansen & Co., Grand Forks.

Lab. No. 612.
Brand, Strawberries, Boyer's.
Producer or jobber, W. W. Boyer & Co., Baltimore, Md.
Retailer, J. O. Hansen, Churchs Ferry.

Lab. No. 616.
Brand, Cherry Preserves, Heinz's.
Producer or jobber, H. J. Heinz Co., Pittsburg, Pa.
Retailer, C. T. Studness, Churchs Ferry.

Lab. No. 655.
Brand, Fort Snelling Strawberries.
Jobber, Foley Bros, & Kelly, St. Paul.
Retailer, L. LaMoure & Co., Neche, N. D.

Lab. No. 755.
Brand, Navy Black Raspberries.
Producer or jobber, Coob Preserving Co. Fairport, N. Y.
Jobber, Foley Bros. & Kelly, St. Paul.

Lab. No. 760.
Brand, Peerless Strawberries.
Producer, C. H. Pearson Packing Co., Baltimore, Md.
Retailer, Fargo Mercantile Co., Fargo.

Lab. No. 762.
Brand, Peerless Raspberries, Preserved Red.
Producer, C. H. Pearson Packing Co., Baltimore, Md.
Retailer, Fargo Mercantile Co., Fargo.

Lab. No. 763.
Brand, Peerless Blueberries.
Producer, C. H. Pearson Packing Co., Baltimore, Md.
Retailer, Fargo Mercantile Co., Fargo.

Lab. No. 791.
Brand, Monogram Black Raspberries.
Producer or jobber, Winston, Harper & Fisher, Minneapolis.

Lab. No. 835.
Brand, West Shore Black Raspberries.
Producer, Newark, N. J.

Lab. No. 836.
Brand, University Preserved Strawberries.
Producer or jobber, Winston, Harper & Fisher, Minneapolis.

Lab. No. 844.
Brand, Jack Rose Strawberries.
Producer, Fleming & Co., Baltimore, Md.
Jobber, Park, Grant & Morris, Fargo.

Lab. No. 847.
Brand, America Red Raspberries.
Producer, Kidwell Bros. & Co., Baltimore, Md.
Jobber, Park, Grant & Morris, Fargo.

Lab. No. 848.
Brand, America Strawberries.
Producer, Kidwell Bros. & Co., Baltimore, Md.
Jobber, Park, Grant & Morris, Fargo.

Lab. No. 849.
Brand, America Blueberries.
Producer, Kidwell Bros. & Co., Baltimore, Md.
Jobber, Park, Grant & Morris, Fargo.

Lab. No. 864.
Brand, Extra Black Raspberries.
Producer, Geneva Preserving Co., Geneva, N. Y.

Lab. No. 865.
Brand, Extra Blackberries.
Producer, Geneva Preserving Co., Geneva, N. Y.

Lab. No. 866.
Brand, Preserved Red Raspberries.
Producer, Geneva Preserving Co., Geneva, N. Y.

Lab. No. 906.
Brand, University Preserved Black Raspberries.
Producer or jobber, Winston, Harper, Fisher & Co., Minneapolis

Lab. No. 907.
Brand, University Blackberries.
Producer or jobber, Winston, Harper, Fisher & Co., Minneapolis.

Lab. No. 908.
Brand, Monogram, Red Raspberries.
Producer or jobber, Winston, Harper, Fisher & Co., Minneapolis.

Lab. No. 909.
Brand, University Red Raspberries.
Producer, Winston, Harper, Fisher & Co., Minneapolis.

Lab. No. 918.
Brand, Spring Apricots.
Producer, Bay Counties Preserving Co., San Francisco, Cal.
Retailer, Park, Grant & Morris, Fargo.

Lab. No. 919.
Brand, Spring Lemon Cling Peaches.
Producer, Bay Counties Preserving Co. San Francisco, Cal.
Jobber, Park, Grant & Morris, Fargo.

Lab. No. 920.
Brand, Spring Bartlett Pears.
Producer, Bay Counties Preserving Co., San Francisco, Cal.
Jobber, Park, Grant & Morris, Fargo.

Lab. No. 937.
Brand, Shield Strawberries.
Producer, J. S. Farren & Co., Baltimore, Md.

Lab. No. 950.
Brand, Monogram Black Raspberries.
Producer or jobber, Winston, Harper, Fisher & Co., Minneapolis.
Retailer, S. C. Tooker & Co., Minneapolis.

Lab. No. 951.
Brand, Monogram Blackberries.
Producer, Winston, Harper, Fisher & Co., Minneapolis.
Retailer, S. C. Tooker & Co., Minneapolis.

Lab. No. 952.
Brand, Monogram Red Raspberries.
Producer, Winston, Harper, Fisher & Co., Minneapolis.
Retailer, S. C. Tooker & Co., Minneapolis.

Lab. No. 1001.
Brand, Monarch Red Raspberries.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, A. Haas, Jamestown.

Lab. No. 1034.
Brand, Pure Fruit Jam, Plum.
Producer or jobber, Reid, Murdock & Co., Chicago.

Lab. No. 1035.
Brand, Batavia Red Pitted Cherries.
Producer, Batavia Preserving Co., Batavia, N. Y.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 1036.
Brand, Yellow Crawford Peaches.
Producer, J. H. Flickinger Co., San Jose, Cal.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 1054.
Brand, Baldwin Apples.
Producer, Erie Preserving Co., Buffalo, N. Y.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 1055.
Brand, Amazon White Cherries.
Producer, Haywards Canning Co., Haywards, Cal.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 1056.
Brand, Bartlett Pears.
Producer, J. H. Flickinger Co., San Jose, Cal.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 1060.
Brand, Monarch Apricots.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 1062.
Brand, Monarch Extra Red Raspberries.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 1063.
Brand, Batavia Crab Apples.
Producer, Batavia Preserving Co., Batavia, N. Y.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 1070.
Brand, Our Choice Bartlett Pears.
Producer, King Morse Canning Co., San Francisco, Cal.
Retailer, T. E. Yerxa, Fargo.
Lab. No. 1076.
Brand, Monarch Pineapple.
Producer, Reid, Murdock & Co., Chicago.
Retailer, T. E. Yerxa, Fargo.
Lab. No. 1078.
Brand, Yellow Peaches.
Producer, John Hunt & Co., Baltimore, Md.
Retailer, T. E. Yerxa, Fargo.
Lab. No. 1089.
Brand, Royal American Batavia White Cherries.
Producer, Batavia Preserving Co., Batavia, N. Y.
Retailer, T. E. Yerxa, Fargo.
Lab. No. 1091.
Brand, Batavia Red Cherry Preserves.
Producer, Batavia Preserving Co., Batavia, N. Y.
Retailer, T. E. Yerxa, Fargo.
Lab. No. 1092.
Brand Orange Marmalade.
Producer, Batavia Preserving Co., Batavia, N. Y.
Retailer, T. E. Yerxa, Fargo.
Lab. No. 1094.
Brand, Batavia Red Currant Jam.
Producer, Batavia Preserving Co., Batavia, N. Y.
Retailer, T. E. Yerxa, Fargo.
Lab. No. 1096.
Brand, Batavia Red Currant Jelly.
Producer, Batavia Preserving Co., Batavia, N. Y.
Retailer, T. E. Yerxa, Fargo.
Lab. No. 1097.
Brand, Bishop California Orange Jelly.
Producer, Bishop & Co., Los Angeles, Cal.
Retailer, T. E. Yerxa, Fargo.
Lab. No. 1113.
Brand, Blue Label Red Currant Jelly.
Producer, Curtice Brothers & Co., Rochester, N. Y.
Retailer, McKean & Probert, Wahpeton.
Lab. No. 1212.
Brand, Monarch Red Strawberries.
Producer, Reid, Murdock & Co., Chicago.
Retailer, Fargo Grocery Co., Fargo.
Lab. No. 1240.
Brand, Banquet Yellow Free Peaches.
Producer, Southern California Packing Co., Los Angeles, Cal.
Retailer, Farmers' Supply House, Fargo.

Lab. No. 1241.
Brand, Muscat Grapes, Banquet Brand.
Producer, Southern California Packing Co., Los Angeles, Cal.
Retailer, Farmers' Supply House, Fargo.

Lab. No. 1246.
Brand, Monarch Red Cherries.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, Fargo Grocery Co., Fargo.

Lab. No. 1249.
Brand, Palm Royal Apricots.
Producer, Royal California Packing Co., Los Angeles, Cal.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 1250.
Brand, Peaches, Yellow Crawford.
Producer, Hercules Packing Co., San Francisco, Cal.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 1251.
Brand, California Fruit, Bartlett Pears.
Producer, Hercules Packing Co., San Francisco, Cal.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 1252.
Brand, Dragon Strawberry Preserves.
Producers or jobbers, The Williams Bros. Co., Detroit, Mich.
Retailers, Fargo Grocery Co., Fargo, N. D.

Lab. No. 1259.
Brand, Monarch Sliced Pineapple.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, Fargo Grocery Co., Fargo.

Lab. No. 1310.
Brand, Challenge Strawberries.
Producer, H. S. Lanfais & Co., Baltimore, Md.
Jobber, Foley Brothers & Kelly, St. Paul.

JAMS, JELLIES, PRESERVES, ETC.—ILLEGAL.

Lab. No. 79.
Brand, Monogram Preserved Strawberries.
Producer or jobber, Winston, Harper, Fisher & Co., Minneapolis.
Color, coal tar dye.

Lab. No. 80.
Brand, University Preserved Strawberries.
Producer or jobber, Winston, Harper, Fisher & Co., Minneapolis.
Preservative, saccharin; color, coal tar dye.

Lab. No. 137
Brand, Farren's Shield Strawberries.
Producer or jobber, J. S. Farren & Co., Baltimore, Md.
Retailer, Winston, Harper, Fisher & Co. Minneapolis.
Preservative, saccharin.

Lab. No. 199.
Brand, Strawberries, Home.
Producer or jobber, Griggs, Cooper & Co., St. Paul.
Preservative, benzoic acid or benzoate of soda.

Lab. No. 200.
Brand, Bengal Preserved Strawberries.
Producer or jobber, Griggs, Cooper & Co., St. Paul.
Preservative, benzoic acid; color, added color.

Lab. No. 241.
Brand, Bengal Preserved Strawberries.
Producer or jobber, Griggs, Cooper & Co., St. Paul.
Is not strawberry and contains starch paste.

Lab. No. 242.
Brand, Victor Strawberry Preserves.
Producer or jobber, Griggs, Cooper & Co., St. Paul.
Not pure strawberry fruit.

Lab. No. 312.
Brand, Honey Dew Red Cherry Preserves.
Producer or jobber, Erie Preserving Co., Buffalo, N. Y.
Color, coal tar dye.

Lab. No. 314.
Brand, Honey Dew Preserved Strawberries.
Producer or jobber, Erie Preserving Co., Buffalo, N. Y.
Color, coal tar dye.

Lab. No. 372.
Brand, Newell's Extra Strawberries.
Producer or jobber, Geo. R. Newell, Minneapolis.
Preservative, salicylic acid.

Lab. No. 436.
Brand, Canned Strawberries.
Producer or jobber, Geo. R. Newell, Minneapolis.
Color, coal tar dye.

Lab. No. 456.
Brand, U. S. Preserved Strawberries.
Producer or jobber, U. S. Canning Co., Fredonia, N. Y.
Retailer, Joseph Goodman, Sheldon.
Preservative, salicylic acid.

Lab. No 482.
Brand, Honey Dew Red Raspberry Jam.
Producer or jobber, Erie Preserving Co., Buffalo, N. Y.
Retailer, Ramharter Bros., Oakes.
Color, coal tar dye.

Lab. No. 555.
Brand, Golf Club Raspberry Preserves.
Producer or jobber, Chicago Concentrating Co., Chicago, Ill.
Retailer, Wright, Clarkson Mercantile Co., Duluth, Minn.
Preservative, benzoic acid; color, cochineal.

Lab. No. 556.
Brand, Belmont Raspberries.
Producer or jobber, Chicago Concentrating Co., Chicago, Ill.
Retailer, Wright, Clarkson Mercantile Co., Duluth, Minn.
Preservative, benzoic acid; color, coal tar dye.

Lab. No. 573.
Brand, California Fruit Preserves.
Producer, unknown.
Sent in by W. B. Douglas, Fargo.
Preservative, salicylic acid.

Lab. No. 574.
Brand, Miss Williams' Pure Home Made Raspberry Jelly.
Producer, made in Des Moines, Ia.
Retailer, W. F. Perry, Grand Forks.
Preservative, salicylic acid.

Lab. No. 582.
Brand, Fresh Fruit Extra Quality of Strawberry Jam.
Producer or jobber, Curtice Brothers, Rochester, N. Y.
Retailer, M. W. Hansen & Co., Grand Forks, N. D.
Preservative, benzioc acid.

Lab. No. 603.
Brand, Strawberries.
Producer or jobber, Foley Brothers & Kelly, St. Paul.
Contains coal tar dye.

Lab. No. 615.
Brand, Pure Food Preserved Strawberries.
Producer or jobber, Pure Food Preserving Co., Buffalo, N. Y.
Retailer, C. T. Studness, Churchs Ferry, N. D.
Contains coal tar dye.

Lab. No. 626.
Brand, Home Red Raspberries.
Producer or jobber, Griggs, Cooper & Co., St. Paul.
Retailer, P. A. Jorgenson, Grafton, N. D.

Lab. No. 633.
Brand, Heinz' Currant Jelly.
Producer or jobber, H, J. Heinz & Co., Pittsburg, Pa.
Retailer, H. G. Sprague, Grafton, N. D.
Preservative, sulphites and benzoic acid.

Lab. No. 653.
Brand, Red Currant Jelly.
Producer or jobber, E. S. Cowdry Co., Boston, Mass.
Retailer, W. Crawford & Son, Neche.
Contains coal tar dye.

Lab. No. 700.
Brand, Brighton Strawberry Jam.
Producer or jobber, Curtice Brothers Co., Rochester, N. Y.
Retailer, Devils Lake Co-operative Association.
Preservative, sulphites.

Lab. No. 701.
Brand, Monroe Strawberries.
Producer or jobber, Rochester Preserving Co., Rochester, N. Y.
Retailer, Devils Lake Co-operative Association.
Preservative, formaldehyde.

Lab. No. 712.
Brand, Eagle Grape Jam.
Producer or jobber, Anderson Preserving Co., Camden, N. Y.
Retailer, P. de Fiore, Devils Lake, N. D.
Preservative, sulphites and coal tar dye.

Lab. No. 730.
Brand, Pure Fruit Strawberry Jam.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, A. D. Sprague, Devils Lake, N. D.
Preservative, coal tar dye.

Lab. No. 738.
Brand, Peerless Strawberries.
Producer or jobber, C. H. Pearson Packing Co., Baltimore, Md.
Retailer, F. W. Manns & Son, Devils Lake, N. D.

Lab. No. 741.
Brand, Strawberry Preserves.
Producer or jobber, Curtice Brothers Canning Co., Rochester, N. Y.
Retailer, F. W. Manns & Son., Devils Lake, N. D.
Preservative, sulphites.

Lab. No. 761.
Brand, Peerless Red Cherries.
Producer or jobber, C. H. Pearson Packing Co., Baltimore, Md.
Retailer, Fargo, Mercantile Co., Fargo.
Preservative, borax.

Lab. No. 790.
Brand, Monogram Red Raspberries.
Producer, Winston, Harper, Fisher & Co., Minneapolis.
Preservative, sulphites.

Lab. No. 792.
Brand, Monogram Blackberries.
Producer, Winston, Harper, Fisher & Co., Minneapolis.
Preservative, formaldehyde.

Lab. No. 801.
Brand, Strawberries.
Producer or jobber, Nash Brothers, Grand Forks.
Preservative, coal tar dye.

Lab. No. 802.
Brand, Strawberries.
Producer or jobber, Nash Brothers, Grand Forks.
Preservative, coal tar dye.

Lab. No. 878.
Brand, Clover Leaf Strawberry Jelly.
Producer or jobber, Chicago Concentrating Co., Chicago.
Retailer, box car merchant.
Preservative, borax, sulphites and coal tar dye.

Lab. No. 889.
Brand, Pride of the West Preserved Pure Apple Butter.
Producer or jobber, John Sexton & Co., Chicago.
Retailer, box car merchant.
Preservative, coal tar dye and salicylic acid.

Lab. No. 937.
Brand, Shield Strawberries.
Producer, J. S. Farren & Co., Baltimore, Md.
Retailer, box car merchant.
Preservative, saccharin.

Lab. No. 956.
Brand, Cerises au Marasquin Cherries.
Producer or jobber, Geo. Dalidet & Co., Bordeaux, France.
Retailer, L. Stern, Larimore, N. D.
Preservative, coal tar dye and salicylic acid.

Lab. No. 957.
Brand, Palace Car Preserved Strawberries.
Producer or jobber, Buffalo Preserving Co., Buffalo, N. Y.
Retailer, L. A. Brookes, Larimore.
Preservative, coal tar dye and formaldehyde.

Lab. No. 972.
Brand, Dinner Party Strawberries.
Producer, Orchard Park Canning Co., Erie, N. Y.
Retailer, R. B. Griffith, Grand Forks.
Preservative, coal tar dye.

Lab. No. 976.
Brand, Dinner Party Pitted Red Cherries.
Producer, Orchard Park Canning Co., Erie, N. Y.
Retailer, Colton Bros., Grand Forks.
Preservative, coal tar dye.

Lab. No. 978.
Brand, Cerises au Marasquin.
Producer, Geo. Dalidet & Co., Bordeaux, France.
Retailer, Geo. H. Wilder, Grand Forks.
Colored with coal tar dye.

Lab. No. 980.
Brand, Club House Cherries.
Producer or jobber, Franklin McVeagh & Co., Chicago.
Retailer, John E. Johnson, Grand Forks.
Preservatives, benzoic acid, borax and coal tar dye.

Lab. No. 983.
Brand, Dinner Party Strawberry Jam.
Producer, Erie Preserving Co., Buffalo, N. Y.
Retailer, K. M. Nass & Co., Grand Forks.
Not pure strawberry and improperly labeled.

Lab. No. 984.
Brand, Red Pitted Cherries.
Producer, Curtice Brothers, Rochester, N. Y.
Retailer, K. M. Nass & Co., Grand Forks.
Preservative, borax and coal tar dye.

Lab. No. 1002.
Brand, Victory Preserved Red Raspberries.
Producer, John Boyle Co., Baltimore, Md.
Retailer, A. Haas, Jamestown.
Preservative, saccharin.

Lab. No. 1009.
Brand, Pride of Rome Preserved Red Raspberries.
Producer, Olney Brothers, Rome, N. Y.
Retailer, G. E. Lyman, Jamestown.
Preservative, benzoic acid.

Lab. No. 1024.
Brand, Crown Princess Strawberry Jam.
Producer or jobber, Erie Preserving Co., Buffalo, N. Y.
Retailer, Park, Grant & Morris, Fargo.
Preservative, coal tar dye.

Lab. No. 1033.
Brand, Preserved Cherries.
Producer or jobber, Bishop & Co., Los Angeles, Cal.
Retailer, T. E. Yerxa, Fargo.
Contains coal tar dye.

Lab. No. 1048.
Brand, Eagle Strawberry Jam.
Producer or jobber, Anderson Preserving Co., Camden, N. Y.
Retailer, J. H. Hansen, Hillsboro.
Colored with coal tar dye.

Lab. No. 1074.
Brand, California Fruit Black Cherries.
Producer, Hercules Packing Co., San Francisco, Cal.
Retailer, T. E. Yerxa, Fargo.
Preservative, borax.

Lab. No. 1090.
Brand, Monarch Extra Preserved Strawberries.
Producer, Reid, Murdock & Co., Chicago.
Retailer, T. E. Yerxa, Fargo.
Colored with coal tar dye.

Lab. No. 1090.
Brand, Strawberries.
Producer or jobber, Bishop & Co., Los Angeles, Cal.
Retailer, T. E. Yerxa, Fargo.
Colored with coal tar dye.

Lab. No. 1104.
Brand, Bengal Strawberry Preserves.
Producer or jobber, Griggs, Cooper & Co., St. Paul.
Retailer, Brueger Mercantile Co., Williston, N. D.
Preservative, sulphites.

Lab. No. 1116.
Brand, Honey Dew Red Cherries.
Producer or jobber, Erie Preserving Co., Buffalo, N. Y.
Retailer, McKean & Probert, Wahpeton, N. D.
Colored with coal tar dye.

Lab. No. 1121.
Brand, Bigarreaux au Marasquin.
Producer or jobber, Geo. Dalidet & Co., Bordeaux, France.
Jobber, R. U. Delapenha & Co., New York.
Colored with coal tar dye.

Lab. No. 1152.
Brand, Certified Pitted Red Cherries.
Producer or jobber, North Collins Preserving Co., North Collins, N. Y.
Retailer, Leach, Gamble, Dexter & Co., Wahpeton.
Colored with coal tar dye.

Lab. No. 1189.
Brand, Peerless Strawberries.
Producer, C. H. Pearson Packing Co., Baltimore, Md.
Retailer, Farmers' Supply House, Fargo.
Preservative, salicylic acid.

Lab. No. 1280.
Brand, Monarch Strawberries.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, Fargo Grocery Co., Fargo.
Colored with coal tar dye and contains salicylic acid.

Lab. No. 1289.
Brand, Shield Blackberries.
Producer or jobber, J. S. Farren & Co., Baltimore, Md.
Retailer, Lewis Vidger Loomis, Fargo.
Sweetened with saccharin.

Lab. No. 1292.
Brand, Shield Strawberries.
Producer, J. S. Farren & Co., Baltimore, Md.
Retailer, Lewis Vidger Loomis, Fargo.
Preservative, salicylic acid.

Lab. No. 1312.
Brand, Shield Red Raspberries.
Producer or jobber, J. S. Farren & Co., Baltimore, Md.
Retailer, Lewis Vidger Loomis, Fargo.
Sweetened with saccharin.

CORN AND SUCCOTASH—LEGAL.

Lab. No. 292.
Brand, Lilac.
Producers, Kelly Canning Co., Waverly, Iowa.
Jobbers, Griggs, Cooper & Co., St. Paul.

Lab. No. 293.
Brand, Red Oak.
Producers, Camden Packing Co., Camden, N. Y.

Lab. No. 481.
Brand, Jewett's High Grade
Retailers, Jewett Brothers, Aberdeen, S. D.

Lab. No. 511.
Brand, Gilman's Early Crosby.
Producers, Gilman Canning Co., Gilman, Ia.
Retailer, Hurley Bros., Forman, N. D.

Lab. No. 578.
Brand, Pine Cone.
Producers, Valley Canning Co., Eau Caire, Wis.
Retailers, Salstad & Bookes, Grand Forks, N. D.

Lab. No. 579.
Brand, Lincoln.
Producers, Lowell Canning Co., Lowell, N. Y.
Retailer, Salstad & Bookes, Grand Forks, N. D.

Lab. No. 610.
Brand, Succotash, Lakeside.
Producers, Snowflake Canning Co., Brunswick, Me.
Retailers, S. S. Moen, Churchs Ferry.

Lab. No. 702,
Brand, Napoleon.
Producers, Waterloo Canning Co., Waterloo, Ia.
Retailers, Devils Lake Co-operative Association.

Lab No. 717.
Brand, Early Sweet.
Producers, Curtice Brothers, Rochester, N. Y.
Retailers, P. de Fiore, Devils Lake.

Lab. No. 740.
Brand, Bengal.
Producers, Griggs, Cooper & Co., St. Paul.
Retailer, F. W. Manns & Son, Devils Lake, N. D.

Lab. No. 742.
Brand, Empress.
Producers, Baxter Brothers, Brunswick, Me.
Retailers, Monsen Brothers & Co., Brocket, N. D.

Lab. No. 799.
Brand, Winnebago.
Producers, Lake Mills Canning Co., Lake Mills, Ia.
Retailers, Nash Brothers, Grand Forks.

Lab. No. 808
Brand, University.
Producers, Winston, Harper, Fisher & Co., Minneapolis.

Lab. No. 822.
Brand, Lake Mills.
Producers, Lake Mills Canning Co., Lake Mills, Ia.

Lab. No. 953.
Brand, Vinton.
Producers, Iowa Canning Co., Vinton, Ia.
Retailers, Park, Grant & Morris, Fargo.

Lab. No. 973.
Brand, Pure Food.
Producers, Pure Food Preserving Co., Buffalo, N. Y.
Retailers, R. B. Griffith, Grand Forks.

Lab. No. 982.
Brand, Blackhawk.
Producers, Waterloo Canning Co., Waterloo, Ia.
Retailers, K. M. Nass & Co., Grand Forks.

Lab. No. 1006.
Brand, Pride of Rome.
Producers, Olney Brothers, Rome, N. Y.
Retailers, Wm. O'Hara, Bismarck.

Lab. No. 1012.
Brand, Carol.
Producers, Geo. R. Newell, Minneapolis.
Retailers, Churchill Webster Co., Jamestown.

Lab. No. 1042.
Brand, Garrison County Club.
Producers, Iowa Canning Co., Garrison, Ia.
Retailers, Fargo Mercantile Co., Fargo, N. D.

Lab. No. 1071.
Brand, Succotash, Batavia.
Producers, Batavia Preserving Co., Batavia, N. Y.
Retailers, T. E. Yerxa, Fargo.

Lab. No. 1100.
Brand, Wisconsin Maiden.
Producers, Dodgeville Canning & Mfg. Co., Dodgeville, Wis
Retailers, T. E. Yerxa, Fargo.
Lab. No. 1101.
Brand, Pride of Cannon Valley.
Producers, Faribault Canning Co., Faribault, Minn.
Retailers, T. E. Yerxa, Fargo.
Lab. No. 1107.
Brand, Gopher.
Producers, Foley Brothers & Kelly, St. Paul.
Retailers, Hedderich Brothers & Co., Williston, N. D.
Lab. No. 1108.
Brand, Plymouth.
Producers, Bangor Packing Co., Bangor.
Retailers, Hedderich Brothers & Co., Williston, N. D.
Lab. No. 1112.
Brand, Millionaire's Club.
Producers, Fenton Brothers & Co., Fenton, N. Y.
Retailers, Jas. Purdon & Co., Wahpeton, N. D.
Lab. No. 1238.
Brand, Pride of Rome.
Producers, Olney Canning Co., Oneida, N. Y.
Retailers, Fargo Grocery Co., Fargo.
Lab. No. 1265.
Brand, White Horse.
Producers, Reid, Murdock & Co., Chicago
Retailers, Fargo Grocery Co., Fargo.
Lab. No. 1271.
Brand, Plymouth.
Producers, Bangor Packing Co., Bangor.
Jobbers, Foley Brothers & Kelly, St. Paul.
Lab. No. 1283.
Brand, Old Colony.
Producers, Faribault Canning Co., Faribault, Minn.
Jobbers, Griggs, Cooper & Co., St. Paul.
Lab. No. 1284.
Brand, Root River.
Producers, Chatfield Canning Co., Chatfield, Minn.
Jobbers, Griggs, Cooper & Co., St. Paul.
Lab. No. 1294.
Brand, Gopher.
Producers, Foley Brothers & Kelly, St. Paul.
Lab. No. 1300.
Brand, Marshalltown.
Producers, Marshalltown Canning Co., Marshalltown, Ia.
Retailers, Foley Brothers & Kelly, St. Paul.

Lab. No. 1302.
Brand, Pride of Rome.
Producers, Olney Brothers, Rome, N. Y
Retailers, Fargo Grocery Co., Fargo.

Lab. No. 1306.
Brand, Succotash, Gopher.
Producers, Foley Brothers & Kelly, St. Paul.

Lab. No. 1347.
Brand, Monarch.
Producers, Reid, Murdock & Co., Chicago.
Retailers, T. E. Yerxa, Fargo.

Lab. No. 1348.
Brand, Tremaine.
Producers, Reid, Murdock & Co., Chicago.
Retailers, T. E. Yerxa, Fargo.

CORN AND SUCCOTASH—ILLEGAL.

Lab. No. 342.
Brand, Extra Choice, Canton.
Producers or jobbers, Canton Canning Co., Canton, Mo.
Retailers, Foley Bros. & Kelly, St. Paul.
Preservative, sulphites.

Lab. No. 348.
Brand, Rockwell.
Producers or jobbers, Rockwell City Canning Co., Rockwell, Ia.
Retailers, Foley Bros. & Kelly, St. Paul.
Preservative, sulphites.

Lab. No. 435.
Producers or jobbers, Anthony Kelly & Co., Minneapolis.
Preservative, sulphites.

Lab. No. 495.
Brand, Faribault Extra Old Colony.
Producers or jobbers, Faribault Canning Co., Faribault, Minn.
Retailers, Klein & Sutmar, Oakes.
Preservative, sulphites.

Lab. No. 545.
Brand, Waldorf.
Producers or jobbers, Metropolitan Canning Co., Rome, N. Y.
Retailers, Wm. O'Hara, Bismarck.
Preservatives, sulphites, saccharin.

Lab. No. 611.
Brand, Newark Sweet Corn.
Producer or jobber, Wayne County Preserving Co., Newark. N. Y.
Retailers, S. S. Moen, Churchs Ferry.
Preservative, sulphites.

Lab. No 620.
Brand, Glenwood.
Producers or jobbers, New Glenwood Canning Co., Glenwood, Ia.
Retailers, Chas. Moore & Son, Grafton, N. D.
Preservatives, sulphites and saccharin..

Lab. No. 652.
Brand, Carol.
Producers, Geo. R. Newell & Co., Minneapolis.
Retailers, W. Crawford & Son, Neche, N. D.
Preservative, large amount of suphites.

Lab. No. 656.
Brand, Plymouth.
Producers, Bangor Packing Co., Bangor, Mo.
Retailers, J. LaMoure, Neche, N. D.
Preservative, contains large amount of sulphite.

Lab. No. 716.
Brand, Log Cabin Succotash.
Producers, F. & I. J. White, Blossvale, N. Y.
Retailers, P. de Fiore, Devils Lake, N. D.
Preservative, contains sulphites.

Lab. No. 765.
Brand, No. A.
Producers, Burt Olney Canning Co., Oneida, N. Y.
Preservatives, sulphites.

Lab. No. 766.
Brand, No. B.
Producers, Burt Olney Canning Co., Oneida, N. Y.
Preservatives, sulphites and saccharin.

Lab. No. 1037.
Brand, Faribault Extra Old Colony.
Producers, Faribault Canning Co., Faribault, Minn.
Retailers, Pure Food Depot, Fargo.
Preservative, formaldehyde.

Lab. No. 1047.
Brand, Vernon.
Producers, Curtice Canning Co., Rochester, N. Y.
Retailers, J. E. Paulson, Hillsboro, N. D.
Preservatives, formaldehyde and saccharin.

Lab. No. 1084.
Brand, Artesian.
Producers, Minnesota Valley Canning Co., Le Sueur, Minn.
Retailer, T. E. Yerxa, Fargo.
Preservative, formaldehyde.

Lab. No. 1093.
Brand, Monarch Succotash.
Producers, Reid, Murdock & Co., Chicago.
Retailers, T. E. Yerxa, Fargo.
Preservative, saccharin.

Lab. No. 1115.
Brand, Blue Label.
Producers, Curtice Brothers, Rochester, N. Y.
Retailers, McKean & Probert, Wahpeton, N. D.
Preservative, saccharin.

Lab. No. 1150.
Brand, Batavia.
Producers, Batavia Preserving Co., Batavia, N. Y.
Retailers, T. E. Yerxa, Fargo.
Preservatives, saccharin.

Lab. No. 1195.
Brand, Early Sweet.
Producers, Curtice Brothers, Rochester, N. Y.
Retailers, F. W. Manns & Son., Devils Lake, N. D.
Preservatives, saccharin.

Lab. No. 1262.
Brand, Monarch.
Producers, Reid, Murdock & Co., Chicago.
Retailers, Fargo Grocery Co., Fargo.
Preservative, saccharin.

Lab. No. 1268.
Brand, U. S.
Producers, U. S. Canning Co., Fredonia, N. Y.
Retailers, Lewis Vidger Loomis, Fargo.
Preservative, saccharin and sulphites.

Lab. No. 1274.
Brand, Alice Rose.
Producers, Fernald Keene & True Co, West Poland, Me.
Retailers, Foley Brothers & Kelly, St. Paul.
Preservative, saccharin.

Lab. No. 1290.
Brand, Glenwood.
Producers, New Glenwood Canning Co., Glenwood, Iowa.
Retailers, Foley Brothers & Kelly, St. Paul.
Preservative, saccharin.

PEAS AND BEANS—LEGAL.

Lab. No. 114.
Brand, Monitor.
Producer or jobber, Lang Canning Co., Eau Claire, Wis.
Retailer, Mr. Grant, Fargo.

Lab. No. 208.
Brand, Barron.
Producer or jobber, N. Wis. Canning Co., Barron, Wis.
Retailer, S. C. Tooker & Co., Minneapolis.
Lab. No. 209.
Brand, Barron.
Producer or jobber, N. Wis. Canning Co., Barron, Wis.
Retailer, S. C. Tooker & Co., Minneapolis.
Lab. No. 210.
Brand, Marrow Fat Barron.
Producer or jobber, N. Wis. Canning Co., Barron, Wis.
Retailer, S. C. Tooker & Co., Minneapolis.
Lab. No. 211.
Brand, Standard Barron.
Producer or jobber, N. Wis. Canning Co., Barron, Wis.
Retailer, S. C. Tooker & Co., Minneapolis.
Lab. No. 279.
Brand, Reynolds Sweet Early June Peas.
Producer or jobber, Reynolds Preserving Co., Sturgeons Bay. Wis.
Retailer, Griggs, Cooper & Co., St. Paul.
Lab. No. 281.
Brand, Bengal.
Producer or jobber, Griggs, Cooper & Co., St. Paul.
Lab. No. 283.
Brand, Bengal.
Producer or jobber, Griggs, Cooper & Co., St. Paul.
Lab. No. 287.
Brand, Home.
Producer or jobber, Griggs, Cooper & Co., St. Paul.
Lab. No. 315.
Brand, Honey Dew.
Producer or jobber, Erie Preserving Co., Buffalo, N. Y.
Lab. No. 316.
Brand, Honey Dew.
Producer or jobber, Erie Preserving Co., Buffalo, N. Y.
Lab. No. 328.
Brand, Barron.
Producer or jobber, N. Wis. Canning Co., Barron, Wis.
Retailer, Foley Bros. Bros. & Kelly, St. Paul.
Lab. No. 336.
Brand, Early June.
Producer or jobber, Fort Atkinson Canning Co., Fort Atkinson, Wisconsin.
Lab. No. 346.
Brand, Little Quaker.
Producer or jobber, W. R. Roach & Co., Hart, Mich.
Retailer, Foley Bros. & Kelly, St. Paul.

Lab. No. 349.
Brand, New York State Beans.
Producer or jobber, Rochester Preserving Co., Rochester, N. Y.
Retailer, Foley Bros. & Kelly, St. Paul.

Lab. No. 352.
Brand, White Wax Beans.
Producer or jobber, Foley Bros. & Kelly, St. Paul.

Lab. No. 366.
Brand, Lima No. 10 Beans.
Producer or jobber, Foley Bros. & Kelly, St. Paul.

Lab. No. 728A.
Brand, White Horse Peas.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, A. D. Sprague, Devils Lake, N. D.

Lab. No. 739.
Brand, Sweet Garden Peas.
Producer or jobber, Curtice Brothers Co., Rochester, N. Y.
Retailer, F. W. Manns, Devils Lake, N. D.

Lab. No. 764.
Brand, Lakeside Peas.
Producer or jobber, Albert Landreth Co., Manitowoc, Wis.
Retailer, Geo. H. Wilder, Grand Forks.

Lab. No. 777.
Brand, No. C Peas.
Producer or jobber, Burt Olney Canning Co., Oneida, N. Y.

Lab. No. 811.
Brand, Monogram Peas.
Producer or jobber, Winston, Harper, Fisher & Co., Minneapolis

Lab. No. 813.
Brand, Monogram Beans.
Producer or jobber, Winston, Harper, Fisher & Co., Minneapolis

Lab. No. 843.
Brand, First Quality String Beans.
Producer or jobber, Fisher & Hoen, Baltimore, Md.
Retailer, Park, Grant & Morris, Fargo.

Lab. No. 845.
Brand, First Quality Golden Wax String Beans.
Producer or jobber, J. S. Farren & Co., Baltimore, Md.
Retailer, Park, Grant & Morris, Fargo.

Lab. No. 875.
Brand, Barron Early June Peas.
Producer or jobber, North Wis. Canning Co., Barron, Wis.
Retailer, box car merchant.

Lab. No. 910.
Brand, Petit Pois, Extra Fine.
Producer or jobber, George Dalidet & Co., Bordeaux, France.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 911.
Brand, Lakeside, Champion of England Peas.
Producer, Albert Landreth Co., Manitowoc, Wis.
Retailer, Geo. H. Wilder, Grand Forks.

Lab. No. 1066.
Brand, Genesee County, Refuge Stringless Beans.
Producer, Batavia Preserving Co., Batavia, N. Y.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 1067.
Brand, Telephone Peas.
Producer or jobber, Yerxa Brothers, Minneapolis.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 1068.
Brand, Monarch Extra Lima Beans.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 1072.
Brand, Monarch Extra String Beans.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 1073.
Brand, Four Track Marrow Fat Peas.
Producer or jobber, S. E. DeCoster, Batavia, N. Y.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 1077.
Brand, Monarch Kidney Beans.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 1079.
Brand, Monarch White Wax Beans.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 1083.
Brand, Monarch Extra French String Beans.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 1085.
Brand, Batavia French Lima Beans.
Producer or jobber, Batavia Preserving Co., Batavia, N. Y.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 1087.
Brand, Batavia Fang Beans.
Producer or jobber, Batavia Preserving Co., Batavia, N. Y.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 1088.
Brand, Batavia Telephone Peas.
Producer or jobber, Batavia Preserving Co., Batavia, N. Y.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 1127.
Brand, Leopard Early June Peas.
Producer or jobber, Geo. R. Newell & Co., Minneapolis.
Retailer, Newman & Williamson, Grandin, N. D.
Lab. No. 1184.
Brand, Sieward's Pride Lima Beans, Bee Hive Brand.
Producer or jobber, F. H. Sieward & Co., Baltimore, Md.
Retailer, Farmers' Supply House, Fargo.
Lab. No. 1187.
Brand, Peerless White Wax Beans.
Producer or jobber, C. H. Pearson Packing Co., Baltimore, Md.
Retailer, Farmers' Supply House, Fargo.
Lab. No. 1225.
Brand, U. S. Lima Beans.
Producer or jobber, U. S. Canning Co., Fredonia, N. Y.
Retailer, Lewis Vidger Loomis Co., Fargo.
Lab. No. 1226.
Brand, Shield String Beans.
Producer or jobber, J. S. Farren & Co., Baltimore, Md.
Retailer, Lewis Vidger Loomis Co., Fargo.
Lab. No. 1228.
Brand, Maine's Golden West Lima Bean.
Producer or jobber, Portland Packing Co., Portland, Me.
Retailer, Lewis Vidger Loomis Co., Fargo.
Lab. No. 1258.
Brand, Monarch French String Beans.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, Fargo Grocery Co, Fargo.
Lab. No. 1260.
Brand, Monarch Sweet Peas.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, Fargo Grocery Co, Fargo.
Lab. No. 1263.
Brand, Reindeer Early June Peas.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, Fargo Grocery Co, Fargo.
Lab. No. 1264.
Brand, Reindeer String Beans.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, Fargo Grocery Co, Fargo.
Lab. No. 1267.
Brand, Shield Refuge Beans.
Producer or jobber, J. S. Farren & Co., Baltimore, Md.
Retailer, Lewis Vidger Loomis Co., Fargo.
Lab. No. 1277.
Brand, Pride of Rome, Early June Sifted Peas.
Producer or jobber, Olney Canning Co., Oneida, N. Y.
Retailer, Fargo Grocery Co, Fargo.

Lab. No. 1296.
Brand, Fort Snelling Early June Peas.
Producer or jobber, Foley Brothers & Kelly, St. Paul.

Lab. No. 1299.
Brand, Gopher Early June Peas.
Producer or jobber, Foley Bros. & Kelly, St. Paul.

Lab. No. 1304.
Brand, Pride of Rome June Peas.
Producer or jobber, Olney Canning Co., Oneida, N. Y.
Retailer, Fargo Grocery Co, Fargo.

Lab. No. 1307.
Brand, Gopher Lima Beans.
Producer or jobber, Foley Bros. & Kelly, St. Paul.

PEAS AND BEANS—ILLEGAL.

Lab. No. 115.
Brand, Valley.
Producer or jobber, Valley Canning Co., Eau Claire, Wis.
Retailer, Mr. Grant, Fargo.
Preservative, borax or boracic acid.

Lab. No. 764.
Brand, Lakeside.
Producer or jobber, Albert Landreth Co., Manitowoc, Wis.
Retailer, Geo. H. Wilder, Grand Forks.
Preservative, gives reaction for formaldehyde.

Lab. No. 778.
Brand, D.
Producer or jobber, Burt Olney Canning Co., Oneida, N. Y.
Preservative, saccharin.

*Lab. No. 793.
Brand, Monogram Beans.
Producer or jobber, Winston, Harper, Fisher & Co., Minneapolis
Preservative, formaldehyde, large amount.

*Lab. No. 807.
Brand, University Beans.
Producer or jobber, Winston, Harper, Fisher & Co., Minneapolis
Preservative, formaldehyde, large amount.

*Lab. No. 809.
Brand, Monogram Small Stringless Beans.
Producer or jobber, Winston, Harper, Fisher & Co., Minneapolis
Preservative, formaldehyde, large amount.

*Lab. No. 810.
Brand, Monogram Refuge Stringless Beans.
Producer or jobber, Winston, Harper, Fisher & Co., Minneapolis
Preservative, formaldehyde, large amount.

* In justice to the jobbers, Winston, Harper, Fisher & Co., it should be said the goods were put up for them by the Vodra Canning Co., Wisconsin, to be accepted if they were found free from preservatives and complied with the North Dakota pure food law. The samples were sent by them to us to see if the packers were complying with the law.

*Lab. No. 812.
Brand, University String Beans.
Producer or jobber, Winston, Harper, Fisher & Co., Minneapolis
Preservative, formaldehyde, large amount.

Lab. No. 893.
Brand Red Rabbit Sifted Early June Peas.
Producer or jobber, E. J. Vodra Canning Co., Two Rivers, Wis.
Retailer, Park, Grant & Morris, Fargo.
Preservative, borax.

Lab. No. 894.
Brand, Blue Diamond Sweet Wrinkled Marrow Fat Peas.
Producer or jobber, E. J. Vodra Canning Co., Two Rivers, Wis.
Retailer, Park, Grant & Morris, Fargo.
Preservative, borax.

Lab. No. 895.
Brand, Blue Diamond Early June Peas.
Producer or jobber, E. J. Vodra Canning Co., Two Rivers, Wis.
Retailer, Park, Grant & Morris, Fargo.
Preservative, borax.

Lab. No. 1186.
Brand, Our Flag Golden Wax Beans.
Producer or jobber, J. Lloyd Jones Canning Co., Lenox, N. Y.
Retailer, Farmers' Supply House, Fargo.
Preservative, saccharin.

Lab. No. 1227.
Brand, Sweet Wisconsin Early June Peas.
Producer or jobber, Reynolds Preserving Co., Sturgeon's Bay, Wis.
Retailer, Lewis Vidger Loomis Co., Fargo.
Preservative, saccharin.

Lab. No. 1253.
Brand, Petit Pois.
Producer or jobber, Jules Fastier & Co., Bordeaux, France.
Retailer, Fargo Grocery Co, Fargo.
Contains copper, also alum.

Lab. No. 1257.
Brand, Monarch White Wax Beans.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, Fargo Grocery Co., Fargo.
Preservative, salicylic acid.

Lab. No. 1261.
Brand, Monarch Early June Peas.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, Fargo Grocery Co., Fargo.
Preservative, borax.

* In justice to the jobbers, Winston, Harper, Fisher & Co., it should be said the goods were put up for them by the Vodra Canning Co., Wisconsin, to be accepted if they were found free from preservatives and complied with the North Dakota pure food law. The samples were sent by them to us to see if the packers were complying with the law.

Lab. No. 1266.
Brand, Shield Refuge Beans.
Producer or jobber, J. S. Farren & Co., Baltimore, Md.
Retailer, Lewis Vidger Loomis Co., Fargo.
Preservative, saccharin.

Lab. No. 1272.
Brand, French Peas.
Producer or jobber, Geo. R. Bard, Bordeaux, France.
Retailer, Foley Bros. & Kelly, St. Paul.
Contains copper, also alum.

Lab. No. 1273.
Brand, French Peas.
Producer or jobber, Jules Dupont.
Retailer, Foley Bros. & Kelly, St. Paul.
Contains copper, also alum.

Lab. No. 1291.
Brand, Fairy Early June Peas, W. N. Killer, Cato, Wis.
Producer or jobber, W. N. Killer, Cato, Wis.
Retailer, Foley Bros. & Kelly, St. Paul.
Contains saccharin.

Lab. No. 1295.
Brand, Gopher White Wax Beans.
Producer or jobber, Foley Bros. & Kelly, St. Paul.
Contains saccharin.

Lab. No. 1298.
Brand, Fort Snelling White Wax Beans.
Producer or jobber, Foley Bros. & Kelly, St. Paul.
Contains saccharin.

Lab. No. 1301.
Brand, Pride of Rome Refuge String Beans.
Producer or jobber, Olney Brothers, Rome, N. Y.
Retailer, Fargo Grocery Co., Fargo.
Contains saccharin.

Lab. No. 1311.
Brand, Fort Snelling Stringless Beans.
Producer or jobber, Foley Bros. & Kelly, St. Paul.
Contains saccharin.

TOMATOES, CANNED—LEGAL OR PASSED.

Lab. No. 260.
Brand, Rose Hill.
Producer or jobber, Chas. Webster, East New Market, Md.
Retailer, Griggs, Cooper & Co., St. Paul.

Lab. No. 277.
Brand, Maryland Beauties.
Producer or jobber, R. E. Roberts & Co., Baltimore, Md.
Retailer, Griggs, Cooper & Co., St. Paul.

Lab. No. 334.
Brand, Great Western.
Producer or jobber, Great Western Canning Co., Wabash, Ind.
Retailer, Foley Bros. & Kelly, St. Paul.

Lab. No. 728.
Brand, Electric.
Producer or jobber, Elkton Canning Co., Elkton, Md.
Retailer, A. D. Sprague, Devils Lake.
A very inferior product.

Lab. No. 788.
Brand, Golden Crown.
Producer or jobber, Aughinbaugh Canning Co., Baltimore, Md.
Retailer, Nash Bros., Grand Forks.

Lab. No. 789.
Brand, Standard Packing, 1903.
Producer or jobber, Strausberg, Steckel, Hewett & Co., Aberdeen, Maryland.
Retailer, Nash Bros., Grand Forks.

Lab. No. 800.
Brand, Pride of Virginia.
Producer or jobber, L. W. Courtney & Son, Mundy's Point, Md.
Retailer, Nash Bros., Grand Forks.

Lab. No. 711.
Brand, Blue Hen's Chickens.
Producer or jobber, J. S. Reynolds & Co., Frederica, Del.
Retailer, Nimmo Bros., Devils Lake.
(Passed.)

Lab. No. 728.
Brand, Electric.
Producer or jobber, Elkton Canning Co., Elkton, Md.
Retailer, A. D. Sprague, Devils Lake, N. D.

Lab. No. 788.
Brand, Golden Crown.
Producer or jobber, Aughinbaugh Canning Co., Baltimore, Md.
Retailer, Nash Brothers, Grand Forks.

Lab. No. 789.
Brand, Standard.
Producer or jobber, Strausberg, Steckel, Hewitt & Co., Aberdeen, Md.
Retailer, Nash Brothers, Grand Forks.

Lab. No. 800.
Brand, Pride of Virginia.
Producer or jobber, L. W. Courtney & Son, Mundy's Point, Md.
Retailer, Nash Brothers, Grand Forks.

Lab No. 846.
Brand, Diamond.
Producer or jobber, D. D. Scully & Co., Baltimore, Md.
Retailer, Park, Grant & Morris, Fargo.

Lab. No. 852.
Brand, Lady Arundel.
Producer or jobber, Geo. M. Murray, Odenton, Md.
Retailer, Park, Grant & Morris, Fargo.

Lab. No. 876.
Brand, Dame's.
Producer or jobber, S. Frank Dashill, Dame's Quarters, Md.
Retailer, box car merchant.

Lab. No. 916.
Brand, Blue Hen's Chickens.
Producer or jobber, J. S. Reynolds & Co., Frederica, Del.
Retailer, Emerson & Hall, St. Paul, Minn.

Lab. No. 928.
Brand, Clayton.
Producer, Clayton Packing Co., Hartford Co., Md.
Retailer, Grand Forks Mercantile Co., Grand Forks.

Lab. No. 948.
Brand, Warwick.
Producer, Evans & Merritt, Middleton, Del.
Retailer, Park, Grant & Morris, Fargo.

Lab. No. 949.
Brand, Van Camp's.
Producer, Van Camp Packing Co., Indianapolis, Ind.
Retailer, Fargo Mercantile Co., Fargo.

Lab. No. 997.
Brand, Model.
Producer or jobber, C. Meyer & Co., Baltimore, Md.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 1021.
Brand, Clay City.
Producer or jobber, Clay City Packing Co., Clay City, Ia.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 1061.
Brand, Batavia.
Producer, Batavia Preserving Co., Batavia, N. Y.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 1065.
Brand, Choice.
Producer, Wayne County Preserving Co., Newark, N. Y.
Retailer, T. E. Yerxa, Fargo.

Lab. No. 1118.
Brand, Dixie's Land.
Producer or jobber, Geo. H. Smith, Miskimon, Va.
Retailer, Wright-Clarkson Mercantile Co., Duluth.

Lab. No. 1126.
Brand, Carol.
Producer or jobber, Geo. R. Newell & Co., Minneapolis.
Retailer, Newman & Williamson, Grandin, N. D.

Lab. No. 1230.
Brand, Monarch.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, Fargo Grocery Co., Fargo.
Lab. No. 1231.
Brand, Gopher.
Producer or jobber, Foley Bros. & Kelly, St. Paul.
Lab. No. 1232.
Brand, Wilna.
Producer or jobber, Geo. Accher, Wilna, Md.
Retailer, Foley Bros. & Kelly, St. Paul.
Lab. No. 1234.
Brand, Fort Snelling.
Producer or jobber, Foley Bros. & Kelly, St. Paul.
Lab. No. 1235.
Brand, Belmont.
Producer or jobber, W. N. Greenland, Cooptown, Md.
Retailer, Foley Bros. & Kelly, St. Paul.
Lab. No. 1236.
Brand, Big R.
Producer or jobber, Robert Brothers, Snow Hill, Md.
Retailer, Foley Bros. & Kelly, St. Paul.
Lab No. 1237.
Brand, Eledin.
Producer or jobber, Clayton Canning Co., Clayton, Del.
Retailer, Foley Bros. & Kelly, St. Paul.
Lab. No. 1270.
Brand, Reindeer.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, Fargo Mercantile Co., Fargo.
Lab. No. 1275.
Brand, Pride of Rome.
Producer or jobber, Olney Canning Co., Oneida, N. Y.
Retailer, Fargo Grocery Co., Fargo.
Lab. No. 1364.
Brand, Premium.
Producer or jobber, Twohy Mercantile Co., West Superior, Wis
Retailer, Thompson Brothers, Cooperstown, N. D.

TOMATO CATSUPS—ILLEGAL.

Lab. No. 35.
Producer or jobber, unknown.
Retailer, Lonbakker, Brocket.
Color, coal tar dye.
Lab. No. 36.
Producer or jobber, unknown.
Retailer, Lonbakker, Brocket.
Color, coal tar dye.

Lab. No. 71.
Brand, Van Camp's Tomato.
Producer or jobber, Van Camp Packing Co., Indianapolis, Ind.
Retailer, Berg Brothers, Cooperstown.
Cost, 15c.
Color, coal tar dye.

Lab. No. 181.
Brand, Libby's Tomato.
Producer or jobber, Libby, McNeill & Libby, Chicago, Ill.
Color, coal tar dye.

Lab. No. 212.
Brand, Snider's Home Made.
Producer or jobber, T. A. Snider Preserv. Co., Cincinnati, Ohio.
Retailer, Winston, Harper, Fisher & Co., Minneapolis.
Color, coal tar dye.

Lab. No. 213.
Brand, Tomato.
Producer or jobber, National Pure Food Co., Cincinnati, Ohio.
Retailer, Winston, Harper, Fisher & Co., Minneapolis.
Color, coal tar dye.

Lab. No. 221.
Brand, Monarch.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, C. J. Calmer, Fargo.
Color, coal tar dye.

Lab. No. 233.
Brand, Home.
Producer or jobber, Griggs, Cooper & Co., St. Paul.
Color, coal tar dye.

Lab. No. 234.
Brand, Colonial.
Producer or jobber, Griggs, Cooper & Co., St. Paul.
Color, coal tar dye.

Lab. No. 355.
Brand, No. 16.
Producer or jobber, Foley Bros. & Kelly, St. Paul.
Color, coal tar dye.

Lab. No. 356.
Brand, No. 17.
Producer or jobber, Foley Bros. & Kelly, St. Paul.
Color, coal tar dye.

Lab. No. 487.
Brand, Ketchup, Sunny Side.
Producer or jobber, Tip Top Ketchup Co., Cincinnati, Ohio.
Retailer, H. V. Hicks & Son, Oakes.
Cost, 15c.
Color, coal tar dye.

Lab. No. 521.
Brand, Minnesota Favorite.
Producer or jobber, M. A. Gedney, St. Paul.
Retailer, Chas. S. Kaufman, Bismarck.
Cost, 15c.
Color, coal tar dye.

Lab. No. 527.
Brand, Butler's Ketchup.
Producer or jobber, Tip Top Ketchup Co., Cincinnati, Ohio.
Retailer, Jamison & Co., Mandan.
Cost, 10c.
Color, coal tar dye.

Lab. No. 549.
Brand, Tiger.
Producer or jobber, Platte & Co., Baltimore, Md.
Retailer, Geo. Gussner, Bismarck.
Cost, 15c.
Color, coal tar dye.

Lab. No. 618.
Brand, Home Comfort.
Producer or jobber, Brant Canning Co., Brant, N. Y.
Retailer, C. T. Studness, Churchs Ferry.
Cost, 15c.
Color, coal tar dye.

Lab No. 703.
Brand, Climax.
Producer or jobber, Chas. F. Louden, Cincinnati, Ohio.
Retailer, Nimmo Bros., Devils Lake.
Color, coal tar dye.

Lab. No. 713.
Brand, Empire.
Producer or jobber, made in St. Louis.
Retailer, P. de Fiore, Devils Lake, N. D.
Preservative, benzoic acid; colored.

Lab. No. 714.
Brand, Eddy's Home Made.
Producer or jobber, Eddy & Eddy, St. Louis, Mo.
Retailer, P. de Fiore, Devils Lake, N. D.
Preservative, benzoic acid; colored.

Lab. No. 729.
Brand, Van Camp Concentrated.
Producer or jobber, Van Camp Packing Co., Indianapolis, Ind.
Retailer, A. D. Sprague, Devils Lake, N. D.
Colored with coal tar dye.

Lab. No. 997.
Brand, Home.
Producer or jobber, Griggs, Cooper & Co., St. Paul.
Contains starch.

Lab. No. 958.
Brand, Minnesota Favorite.
Retailer, L. A. Brookes, Larimore, N. D.
Colored with coal tar dye and contains starch.

Lab. No. 977.
Brand, Monarch.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, Colton Bros., Grand Forks.
Colored with coal tar dye and contains a filler.

Lab. No. 998.
Brand, Monarch.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, T. E. Yerxa, Fargo.
Contains coal tar dye.

Lab. No. 1005.
Brand, Monarch.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, O'Hara Cash Grocery, Bismarck, N. D.
Contains coal tar dye.

TOMATO CATSUPS—LEGAL.

Lab. No. 834.
Brand, Waldorf.
Producer or jobber, The Williams Bros. Co., Detroit, Mich.
Retailer, Grand Forks Mercantile Co., Grand Forks.

Lab. No. 888.
Brand, XXXX.
Producer or jobber, John Sexton & Co., Chicago.
Retailer, box car merchant.

Lab. No. 922.
Brand, Snider's Home Made.
Producer or jobber, T. A. Snider Preserving Co, Cincinnati, O.
Retailer, Park, Grant & Morris, Fargo.

Lab. No. 927.
Brand, Van Camp.
Producer, Van Camp Packing Co., Indianapolis, Ind.
Retailer, A. K. Cochram, Finley, N. D.

Lab. No. 1022.
Brand, Our Favorite.
Producer or jobber, Farnham Canning Co., Farnham, N. Y.
Retailer, Park, Grant & Morris, Fargo.

Lab. No. 1023.
Brand, Crown Prince.
Producer or retailer, Erie Preserving Co., Buffalo, N. Y.
Retailer, Park, Grant & Morris, Fargo.

Lab. No. 1032.
Brand, Home Comfort.
Producer or jobber, Brant Canning Co., Brant, N. Y.
Retailer, Nash Bros., Grand Forks.

Lab. No. 1131.
Brand, White House.
Producer or jobber, Jersey Packing Co., Hamittor, Ohio.
Retailer, Geo. R. Newell & Co., Minneapolis.

Lab. No. 1163.
Brand, Flickertail.
Retailer, Fargo Mercantile Co., Fargo.

Lab. No. 1190.
Brand, Monarch.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, Fargo Grocery Co., Fargo.

Lab. No. 1191.
Brand, Snider's Home Made.
Producer, T. A. Snider Preserving Co., Cincinnati, Ohio.
Retailer, Fargo Grocery Co., Fargo.

Lab. No. 1205.
Brand, Fort Snelling.
Producer or jobber, Foley Bros. & Kelly, St. Paul.

Lab. No. 1206.
Brand, Gopher.
Producer or jobber, Foley Bros. & Kelly, St. Paul.

Lab. No. 1207.
Brand, Blue Label.
Producer or jobber, Curtice Brothers, Rochester, N. Y.
Retailer, Foley Bros. & Kelly, St. Paul.

Lab. No. 1208.
Brand, Snider's Home Made.
Producer, T. A. Snider Preserving Co., Cincinnati, Ohio.
Jobber, Foley Bros. & Kelly, St Paul.

LEMON EXTRACTS—LEGAL.

Lab. No. 92.
Brand, Extra High Grade.
Producer or jobber, Eddy & Eddy, St. Louis, Mo.
Alcohol, high.
Oil of lemon, 8.23 per cent.
Legal and of high strength oil.

Lab. No. 93.
Brand, Double Strength.
Producer or jobber, Nash Brothers, Grand Forks, N. D.
Alcohol, good.
Oil of lemon, 4.78 per cent.
Not of full strength.

Lab. No. 127.
Brand, Purity Triple.
Producer or jobber, Purity Chemical Co., Chicago, Ill.
Alcohol, good.
Oil of lemon, 5 per cent.
Color, foreign.
This color should be left out to be legal.

Lab. No. 130.
Brand, Concentrated.
Producer or jobber, Winston, Harper, Fisher & Co., Minneapolis.
Alcohol, high.
Oil of lemon, 5.62 per cent.
Color, ?.

Lab. No. 182.
Brand, Puritan.
Producer or jobber, Park, Grant & Morris, Fargo, N. D.
Alcohol, high.
Oil of lemon, 5.50 per cent.
Color, natural.

Lab. No. 219.
Producer or jobber, Thompson-Taylor Spice Co., Chicago.
Alcohol, high.
Oil of lemon, 5.50 per cent.
Color, natural.

Lab. No. 378.
Brand, Dainty.
Producer or jobber, J. H. Allen & Co., St. Paul, Minn.
Alcohol, high.
Oil of lemon, 5.93 per cent.

Lab. No. 379.
Brand, B.
Producer or jobber, Griggs, Cooper & Co., St. Paul.
Alcohol, good.
Oil of lemon, 4.69 per cent.
Sample below standard and color questionable.

Lab. No. 380.
Brand, A.
Producer or jobber, Griggs, Cooper & Co., St. Paul, Minn.
Alcohol, high.
Oil of lemon, 5 per cent.
Color, natural.

Lab. No. 428.
Brand, Bastine's.
Producer or jobber, Bastine & Co., New York.
Retailer, W. B. Howland, Fargo.
Oil of lemon, 3.12 per cent.
A pure extract, but not of full strength.

Lab. No. 451.
Brand, Imperial.
Producer or jobber, Karles Medicine Co., Aberdeen, S. D.
Retailer, W. A. Cole, Lisbon, N. D.
Oil of lemon, 5.50 per cent.

Lab. No. 586.
Brand, Booth's.
Producer or jobber, Booth's Medicine Co., St. Cloud, Minn.
Retailer, R. B. Griffith, Grand Forks.
Oil of lemon, 10 per cent.

Lab. No. 602.
Brand, Lemon.
Producer or jobber, Foley Bros. & Kelly, St. Paul.
Oil of lemon, 5.62 per cent.

Lab. No. 622.
Brand, Gillett's.
Producer or jobber, E. W. Gillett, Chicago.
Retailer, Chas. W. Moore & Son, Grafton.
Oil of lemon, 5.62 per cent.

Lab. No. 629.
Brand, Home.
Producer or jobber, Griggs, Cooper & Co., St. Paul.
Retailer, P. A. Jorgenson, Grafton, N. D.
Oil of lemon, 4.72; color, artificial.

Lab. No. 637.
Brand, Fort Snelling.
Producer or jobber, Foley Bros. & Kelly, St. Paul.
Retailer, J. LaMoure, Neche, N. D.
Oil of lemon, 6.24 per cent.
Color, natural.

Lab. No. 695.
Brand, Red Dragon.
Producer or jobber, Bell-Conrad Co., Chicago.
Retailers, Devils Lake Co-operative Association.
Oil of lemon, 4.84 per cent.

Lab. No. 721.
Brand, Atlas Triple.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, P. de Fiore, Devils Lake, N. D.
Oil of lemon, 5.18 per cent.

Lab. No. 727.
Brand, Mrs. Foster's.
Producer or jobber, Mrs. Foster, Duluth, Minn.
Retailer, A. D. Sprague, Devils Lake, N. D.
Oil of lemon, 7.50 per cent.

Lab. No. 732.
Brand, Monarch.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, W. F. Manns & Son, Devils Lake, N. D.
Oil of lemon, 6.22 per cent; colored.

Lab. No. 783.
Brand, Booth's.
Producer or jobber, Booth Medicine Co., St. Cloud, Minn.
Retailer, E. A. Perry, Fargo, N. D.
Oil of lemon, 10.13 per cent.

Lab. No. 902.
Brand, Sexton's High Grade.
Producer or jobber, John Sexton & Co., Chicago.
Retailer, box car merchant.
Oil of lemon, 6.25 per cent.

Lab. No. 945.
Brand, Palace.
Producer or jobber, McCormick, Behnke & Co., St. Paul.
Retailer, Chas. Moore & Son, Grafton, N. D.
Oil ot lemon, 5.62 per cent.

Lab. No. 959.
Brand, McMurray's.
Producer or jobber, Wm. McMurray & Co., St. Paul.
Retailer, Colton Bros., Grand Forks, N. D.
Oil of lemon, 6.40 per cent.

Lab. No. 989.
Brand, 5 per cent Oil of Lemon.
Producer or jobber, Foley Bros. & Kelly, St. Paul.
Oil of lemon, 5.12 per cent.

Lab. No. 1109.
Brand, Schilling's Best.
Retailer, Heddrich Bros. & Co., Williston, N. D.
Oil of lemon, 15.65 per cent.

Lab. No. 1124.
Brand, Newell's Extra.
Producer or jobber, Geo. R. Newell & Co., Minneapolis.
Retailer, Newman & Williamson, Grandin, N. D.
Oil of lemon, 6.06 per cent.

Lab. No. 1340.
Brand, Gillett's Double.
Producer or jobber, E. W. Gillett ,Chicago, Ill.
Retailer, Fargo Grocery Co., Fargo.
Oil of lemon, 5.46 per cent.

Lab. No. 1355.
Brand, Concentrated.
Retailer, Farmers' Supply House, Fargo.
Oil of lemon, 5.65 per cent.

LEMON EXTRACTS—ILLEGAL.

Lab. No. 52.
Brand, Fruit.
Producer or jobber, McCormick, Behnke & Co., St. Paul, Minn.
Alcohol, low.
Oil of lemon, none.
Color, artificial.

Lab. No. 54.
Brand, Palace.
Producer or jobber, McCormick, Behnke & Co., St. Paul, Minn.
Alcohol, low.
Oil of lemon, none.
Color, artificial.

Lab. No. 56.
Brand, Seal.
Producer or jobber, McCormick, Behnke & Co., St. Paul, Minn.
Alcohol, low.
Oil of lemon, none.
Color, artificial.

Lab. No. 64.
Brand, Chapman's.
Producer or jobber, Chapman-Smith Co., Chicago, Ill.
Alcohol, medium.
Oil of lemon, 5.78 per cent.
Color, artificial.
Colored with coal tar dye, but of good strength.

Lab. No. 89.
Brand, Blue Ribbon.
Producer or jobber, Nash Bros., Grand Forks, N. D.
Alcohol, low.
Oil of lemon, none.
Color, artificial.

Lab. No. 131.
Brand, Triple.
Producer or jobber, Winston, Harper, Fisher & Co., Minneapolis
Alcohol, low.
Oil of lemon, .62 per cent.
Color, foreign.

Lab. No. 132.
Brand, Climax.
Producer or jobber, Winston, Harper, Fisher & Co., Minneapolis
Alcohol, low.
Oil of lemon, none.
Color, foreign.

Lab. No. 146.
Brand, Robin.
Producer or jobber, J. H. Allen & Co., St. Paul, Minn.
Alcohol, low.
Oil of lemon, none.
Color, foreign.

Lab. No. 147.
Brand, Dainty.
Producer or jobber, J. H. Allen & Co., St. Paul, Minn.
Alcohol, low.
Oil of lemon, none.

Lab. No. 203.
Brand, Pure.
Producer or jobber, Home Tea Co., Grand Forks, N. D.
Alcohol, low.
Oil of lemon, 2.30 per cent.
Color, coal tar dye.

Lab. No. 220.
Producer or jobber, Thompson-Taylor Spice Co., Chicago.
Alcohol, low.
Oil of lemon, none.
Color, natural.

Lab. No. 307.
Brand, Standard.
Producer or jobber, F. L. Frary & Co., Minneapolis, Minn.
Alcohol, low.
Oil of lemon, none.

Lab. No. 308.
Brand, Belmont.
Producer or jobber, F. L. Frary & Co., Minneapolis, Minn.
Alcohol, low.
Oil of lemon, none.
Color, foreign.

Lab. No. 375.
Brand, Lagneb.
Producer or jobber, Griggs, Cooper & Co., St. Paul, Minn.
Alcohol, low.
Oil of lemon, .15 per cent.
Color, natural.

Lab. No. 376.
Producer or jobber, Foley Bros. & Kelly, St. Paul.
Oil of lemon, none.

Lab. No. 412.
Brand, Sampson's.
Producer or jobber, S. J. Vidger & Co., Fargo, N. D.
Retailer, R. M. Yarrow, Fargo, N. D.
Alcohol, low.
Oil of lemon, .66 per cent.
Color, coal tar dye.

Lab. No. 418.
Brand, Home.
Producer or jobber, Griggs, Cooper & Co., St. Paul, Minn.
Sold by Pure Food Depot, Fargo, N. D.
Alcohol, medium.
Oil of lemon, 3.59 per cent.
Color, foreign.
Contains foreign color and below standard.

Lab. No. 422.
Brand, Standard.
Producer or jobber, Standard Chemical Works, St. Louis, Mo.
Sold by Fulton Market, Fargo, N. D.
Alcohol, low.
Oil of lemon, none.
Color, coal tar dye.

Lab. No. 426.
Producer or jobber, Thompson-Taylor Spice Co., Chicago.
Sold by P. J. Bergquist, Fargo, N. D.
Alcohol, low.
Oil of lemon, 1.09 per cent.
Color, coal tar dye

Lab. No. 428.
Brand, Bastine's.
Producer or jobber, Bastine & Co., New York, N. Y.
Retailer, W. B. Howland, Fargo, N. D.
Alcohol, fair.
Oil of lemon, 3.12 per cent.
Color, natural.
Pure, but low in strength.

Lab. No 438.
Brand, Pure Concentrated.
Producer or jobber, M. S. Davis & Co., Lisbon, N. D.
Retailer, M. S. Davis & Co., Lisbon, N. D.
Alcohol, low.
Oil of lemon, .62 per cent
Color, foreign.

Lab. No. 444.
Brand, Jewell Concentrated.
Producer or jobber, Stone, Ordean, Wells & Co., Duluth, Minn.
Retailer, Cramer Bros., Lisbon, N. D.
Alcohol, low.
Oil of lemon, 1.56 per cent.
Color, coal tar dye.

Lab. No. 450.
Brand, Mrs. Baker's.
Producer or jobber, Geo. R. Newell & Co., Minneapolis, Minn.
Retailer, W. A. Cole, Lisbon, N. D.
Alcohol, low.
Oil of lemon, 1.37 per cent.
Color, coal tar dye.

Lab. No. 458.
Brand, Pure Food.
Producer or jobber, Joseph Goodman, Sheldon, N. D.
Retailer, Joseph Goodman, Sheldon, N. D.
Alcohol, low.
Oil of lemon, 1.06 per cent.
Color, foreign.

Lab. No. 462.
Brand, Anchor.
Producer or jobber, ———, St Paul, Minn.
Retailer, A. A. Burgess, Sheldon, N. D.
Alcohol, low.
Oil of lemon, .69 per cent.
Color, coal tar dye.

Lab. No 467.
Brand, Clear Quill.
Producer or jobber, Corbin Sons & Co., Chicago, Ill.
Retailer, M. Gardner, Lisbon, N. D.
Alcohol, good.
Oil of lemon, 5.62 per cent.
Color, foreign.
Of good strength, but colored with what reacts as coal tar dye.

Lab. No. 477.
Brand, Standard.
Producer or jobber, Boston Chemical Works, Boston, Mass.
Retailer, Marion Grange, Sheldon, N. D.
Alcohol, low.
Oil of lemon, .62 per cent.
Color, foreign.

Lab. No. 478.
Brand, Star.
Producer or jobber, Star Extract Co., Chicago, Ill.
Retailer, Marion Grange, Sheldon, N. D.
Alcohol, low.
Oil of lemon, .50 per cent.
Color, coal tar dye.

Lab. No. 483.
Brand, Nichols.
Producer or jobber, unknown.
Retailer, Ramharter Bros., Oakes, N. D.
Alcohol, medium.
Oil of lemon, 1.35 per cent.
Color, natural.
Pure, but of low strength,

Lab. No. 503.
Brand, Concentrated.
Producer or jobber, John Kneen, LaMoure, N. D.
Retailer, Kuch & Zinck, LaMoure, N. D.
Alcohol, medium.
Oil of lemon, 1.12 per cent.
Color, coal tar dye.

Lab. No. 508.
Brand, Jewell Concentrated.
Producer or jobber, Stone, Ordean, Wells & Co., Duluth, Minn.
Retailer, Deisem & Franks, LaMoure, N. D.
Alcohol, medium.
Oil of lemon, 1.50 per cent.
Color, coal tar dye.

Lab. No. 512.
Brand, Our Leader.
Producer or jobber, Hurley Brothers, Forman, N. D.
Retailer, Hurley Brothers, Forman, N. D.
Alcohol, low.
Oil of lemon, .62 per cent.
Color, coal tar dye.

Lab. No. 528.
Brand, Perfection.
Producer or jobber, Atwood & Steele, Chicago, Ill.
Retailer, Chas, Kupitz, Bismarck, N. D.
Alcohol, medium.
Oil of lemon, 1.37 per cent.
Color, foreign.

Lab. No. 532.
Brand, Double Extract.
Producer or jobber, Atwood & Steele, Chicago, Ill.
Retailer, John Yegen, Bismarck, N. D.
Alcohol, medium.
Oil of lemon, 3.44 per cent.
Color, foreign.
Illegal and improperly labeled.

Lab. No. 534.
Brand, Tillman's.
Producer or jobber, Tillman & Bendel, San Francisco, Cal.
Retailer, John Yegen, Bismarck, N. D.
Alcohol, medium.
Oil of lemon, 1.35 per cent.
Color, coal tar dye.

Lab. No. 544.
Brand, Favorite.
Producer or jobber, Winter Spice Co., Chicago., Ill.
Retailer, Wm. O'Hara, Bismarck, N. D.
Alcohol, low.
Oil of lemon, .31 per cent.
Color, foreign.

Lab. No. 550.
Brand, Kent's Nectar.
Producer or jobber, W. H. Kent, St. Paul, Minn.
Retailer, Geo. Gussner, Bismarck, N. D.
Alcohol, medium.
Oil of lemon, 1.35 per cent.
Color, foreign.

Lab No. 551.
Brand, Hoosier.
Producer or jobber, Atwood & Steele, Chicago, Ill.
Retailer, Geo. Gussner, Bismarck, N. D.
Alcohol, low.
Oil of lemon, .62 per cent.
Color, foreign.

Lab. No. 552.
Brand, Pure and True.
Producer or jobber, Minnesota Spice and Mercantile Co., St. Paul.
Retailer, Geo. Gussner, Bismarck, N. D.
Alcohol, medium.
Oil of lemon, 1.35 per cent.
Color, coal tar dye

Lab. No. 560.
Brand, Meldrum's Triple.
Producer or jobber, Geo. Meldrum, Chicago, Ill.
Alcohol, fair.
Oil of lemon, 4.40 per cent.
Color, foreign.

Lab. No. 571.
Brand, Brook's Diamond.
Producer or jobber, L. A. Brooks, Larimore, N. D.
Retailer, Larimore Packing Co., Larimore, N. D.
Alcohol, high.
Oil of lemon, 9.37 per cent.
Color, coal tar dye.
This is exceptionally high in strength, but improperly colored with coal tar color.

Lab. No. 587.
Brand, Double Strength Honest Bottle.
Producer or jobber, Wm. McMurray & Co., St Paul, Minn.
Retailer, R. B. Griffith, Grand Forks, N. D.
Alcohol, medium.
Oil of lemon, 1.06 per cent.
Very low in strength, and colored with what seems to react for coal tar dye.

Lab. No. 593.
Brand, Pure Food.
Producer or jobber, Johnson & McGowan, Grand Forks, N. D.
Retailer, Johnson & McGowan, Grand Forks, N. D.
Alcohol, low.
Oil of lemon, .93 per cent.
Color, foreign.

Lab. No. 596.
Brand, Seely's.
Producer or jobber, Seely Manufacturing Co., Detroit, Mich.
Retailer, W. F. Perry, Grand Forks.
Alcohol, medium.
Oil of lemon, 1.56 per cent.
Color, coal tar dye.

Lab. No. 608.
Brand, Dainty.
Producer or jobber, J. H. Allen & Co., St. Paul, Minn.
Retailer, S. S. Moen, Churchs Ferry, N. D.
Alcohol, good.
Oil of lemon, 4.38 per cent.
Color, foreign.

Lab. No. 617.
Brand, Souder's.
Producer or jobber, Royal Remedy & Extract Co., Dayton, Ohio
Retailer, C. T. Studness, Churchs Ferry, N. D.
Alcohol, low.
Oil of lemon, none.
Color, foreign.

Lab. No. 638.
Brand, Kenwood.
Producer or jobber, Kenwood Mfg. Co., Chicago, Ill.
Alcohol, low.
Oil of lemon, none.
Color, foreign.

Lab. No. 644.
Brand, Standard.
Producer or jobber, Grand Forks Mercantile Co.
Retailer, Chas. Moen & Son, Grafton, N. D.
Alcohol, low.
Oil of lemon, .88 per cent.
Color, foreign.

Lab. No. 646.
Brand, Standard.
Producer or jobber, Grand Forks Mercantile Co.
Retailer, W. Crawford & Son, Neche, N. D.
Alcohol, low.
Oil of lemon, 1.25 per cent.
Color, foreign.

Lab. No. 648.
Brand, Standard.
Producer or jobber, Gillett's Chemical Works, Chicago, Ill.
Retailer, W. Crawford & Son, Neche, N. D.
Alcohol, low.
Oil of lemon, none.
Color, foreign.

Lab. No. 649.
Brand, Gold Medal.
Producer or jobber, Grand Forks Mercantile Co., Grand Forks
Retailer, W. Crawford & Son, Neche, N. D.
Alcohol, low.
Oil of lemon, .81 per cent.
Color, foreign.

Lab. No. 650.
Brand, Economy.
Producer or jobber, Geo. R. Newell & Co., Minneapolis, Minn.
Alcohol, low.
Oil of lemon, 1.81 per cent.
Color, foreign.

Lab. No. 663.
Brand, Crescent.
Producer or jobber, Lenning, Brown, Wright & Co., Crookston, Minn.
Alcohol, low.
Oil of lemon, .38 per cent.
Color, foreign.

Lab. No. 668.
Brand, Standard.
Producer or jobber, F. L. Frary & Co., Minneapolis, Minn.
Retailer, Murphy, Holmes & Co., Neche, N. D.
Alcohol, low.
Oil of lemon, none.
Color, foreign.

Lab. No. 693.
Brand, Columbia.
Producer or jobber, H. B. Straight & Co., St. Paul, Minn.
Retailer, Devils Lake Co-operative Association.
Alcohol, low.
Oil of lemon, none.
Color, foreign.

Lab. No. 696.
Brand, Robin.
Producer or jobber, J. H. Allen & Co., St. Paul, Minn.
Retailer, Devils Lake Co-operative Association.
Alcohol, low.
Oil of lemon, none.
Color, foreign.

Lab. No. 705.
Brand, Fruit.
Producer or jobber, McCormick, Behnke & Co., St. Paul, Minn.
Retailer, Nimmo Bros., Devils Lake, N. D.
Alcohol, low.
Oil of lemon, none.
Color, foreign.

Lab. No. 719.
Brand, Seal.
Producer or jobber, Kenwood Preserving Co., Chicago, Ill.
Retailer, P. de Fiore, Devils Lake, N. D.
Alcohol, low.
Oil of lemon, none.
Color, foreign.

Lab. No. 728A.
Brand, Triple.
Producer or jobber, Winston, Harper, Fisher & Co., Minneapolis.
Retailer, A. D. Sprague, Devils Lake, N. D.
Alcohol, low.
Oil of lemon, none.
Color, foreign.

Lab. No. 731.
Brand, Bengal.
Producer or jobber, not given on package.
Retailer, F. W. Manns & Son, Devils Lake, N. D.
Alcohol, low.
Oil of lemon, none.
Color, foreign.

Lab. No. 737.
Brand, Gillett's Double.
Producer or jobber, E. W. Gillett, Chicago.
Oil of lemon, 5.17 per cent; colored.

Lab. No. 745.
Brand, Blue.
Producer or jobber, Seabury & Co., St. Paul.
Retailer, Monson Brothers & Co., Brocket, N. D.
Oil of lemon, 4.06 per cent.
Colored.

Lab. No. 747.
Brand, Satisfaction Concentrated.
Producer or jobber, Rush Chemical Co.
Retailer, Math Vaboyda, Lawton, N. D.
Oil of lemon, none, and color foreign.

Lab. No. 751.
Producer or jobber, Thompson, Taylor Spice Co., Chicago.
Retailer, Hutchinson & Libby, Lakota, N. D.
Oil of lemon, none, and color foreign.

Lab. No. 780.
Brand, Gold Medal.
Producer or jobber, Grand Forks Mercantile Co., Grand Forks.
Retailer, J. W. Rush.
Oil of lemon, 1.09 per cent, and color foreign.

Lab. No. 781.
Brand, Peerless.
Producer or jobber, Lenning, Brown, Wright & Co., Crookston.
Retailer, J. W. Rush, Chicago.
Oil of lemon, .62 per cent, and color foreign.

Lab. No. 853.
Brand, North Star.
Producer or jobber, Anthony Kelly & Co., Minneapolis.
Oil of lemon, none.

Lab. No. 990.
Brand, No 2.
Producer or jobber, W. H. Kent, St. Paul.
Oil of lemon, none.

Lab. No. 991.
Brand, No. 1.
Producer or jobber, W. H. Kent, St. Paul.
Oil of lemon, none.

Lab. No. 992.
Brand, No. 3.
Producer or jobber, W. H. Kent, St. Paul.
Oil of lemon, none.

Lab. No. 1000.
Brand, Kent's Nectar.
Producer or jobber, W. H. Kent, St. Paul.
Retailer, Andrew Haas, Jamestown.
Oil of lemon, none, and colored.

Lab. No. 1007.
Brand, Tropical.
Producer or jobber, Atwood & Steele, Chicago.
Retailer, G. G. Lyman, Jamestown.
Oil of lemon, none, and colored.

Lab. No. 1008.
Brand, Pure Concentrated.
Producer or jobber, Joseph Skinner & Co., La Crosse, Wis.
Retailer, G. E. Lyman, Jamestown.
Oil of lemon, none, and colored.

Lab. No. 1103.
Brand, Pure Concentrated.
Producer or jobber, Joseph Skinner & Co., La Crosse, Wis.
Oil of lemon, none.

Lab. No. 1105.
Brand, Perfection.
Producer or jobber, Atwood & Steele, Chicago.
Retailer, Bruegger Mercantile Co., Williston, N. D.
Oil of lemon, 3.27 per cent.

Lab. No. 1171.
Brand, One Per Cent.
Retailer, Farmers' Supply House, Fargo.
Oil of lemon, none, and colored with coal tar dye.

Lab. No. 1211.
Brand, Golden Sheaf.
Producer or jobber, Fargo Mercantile Co., Fargo.
Retailer, Fargo Grocery Co., Fargo.
Oil of lemon, 1.56 per cent, and color foreign.

Lab. No. 1239.
Brand, Golden Sheaf.
Producer or jobber, Fargo Mercantile Co., Fargo.
Retailer, Fargo Grocery Co., Fargo.
Oil of lemon, 1.56 per cent.

VANILLA EXTRACTS—LEGAL.

The following extracts have been found to meet the requirements of the pure food law:

Lab. No. 62.
Brand, Chapman's.
Producer or jobber, Chapman-Smith Co., Chicago, Ill.
Of good strength and legal.

Lab. No. 90.
Brand, Eddy's High Grade.
Producer or jobber, Eddy & Eddy, St. Louis, Mo.
A pure vanilla weak in alcohol and held up by alkali.

Lab. No. 133.
Brand, Concentrated.
Producer or jobber, Winston, Harper, Fisher & Co., Minneapolis.
A pure product of good strength.

Lab. No. 143.
Brand, Dainty.
Producer or jobber, J. H. Allen & Co., St. Paul, Minn.
Apparently pure, but of medium alcohol strength and cut with alkali.

Lab. No. 144.
Brand, Blue Ribbon.
Producer or jobber, J. H. Allen & Co., St. Paul, Minn.
Probably pure, of medium strength alcohol and cut with alkali.

Lab. No. 215.
Brand, Puritan.
Producer or jobber, Park, Grant & Morris, Fargo.
A pure extract of medium strength.

Lab. No. 231.
Brand, No. 1.
Producer or jobber, Griggs, Cooper & Co., St. Paul.
Pure and legal.

Lab. No. 413.
Brand, Puritan.
Producer or jobber, Park, Grant & Morris, Fargo, N. D.
Retailer, R. M. Yarrow, Fargo, N. D.
Pure, of good quality and medium strength.

Lab. No. 417.
Brand, Home.
Producer or jobber, Griggs, Cooper & Co., St. Paul.
Retailer, Pure Food Depot, Fargo, N. D.
An extract of medium strength, but probably illegally colored.

Lab. No. 421.
Brand, Club House.
Producer or jobber, Franklin, McVeagh & Co., Chicago, Ill.
Retailer, Fulton's Market, Fargo, N. D.
Seems to contain some foreign resin, but of good strength.

Lab. No. 429.
Brand, Bastine's.
Producer or jobber, Bastine & Co., New York.
Retailer, W. B. Howland, Fargo, N. D.
An extract of medium strength.

Lab. No. 430.
Brand, Dr. Price's.
Producer or jobber, Price's Flavoring Extract Co., Chicago, Ill.
An extract of good strength.

Lab. No. 439.
Brand, Jewell Concentrated.
Producer or jobber, Stone, Ordean, Wells Co. Duluth, Minn.
Retailer, M. S. Davis, Lisbon, N. D.
Of medium strength.

Lab. No. 457.
Brand, Golden Sheaf.
Producer or jobber, Fargo Mercantile Co., Fargo, N. D.
Retailer, Joseph Goodman, Sheldon, N. D.
An extract of good strength possibly containing a little color.

Lab. No. 466.
Brand, Clear Quill.
Producer or jobber, Corbin Sons & Co., Chicago, Ill.
Retailer, M. Gardner, Lisbon, N. D.
An extract of good strength.

Lab. No. 470.
Brand, Special.
Producer or jobber, Lakota Manufacturing Co., Chicago, Ill.
Retailer, C. S. Kratt, Sheldon, N. D.
Mainly coumarin, with small amount of vanilla.

Lab. No. 484.
Brand, Our Leader.
Producer or jobber, Ramharter Bros., Oakes, N. D.
Retailer, Ramharter Bros., Oakes, N. D.
Of medium strength, but seems to be slightly colored.

Lab. No. 489.
Brand, Victory.
Producer or jobber, Leach, Gamble, Dexter Co., Wahpeton.
Retailer, H. V. Hicks & Son, Oakes, N. D.
Of good strength.

Lab. No. 504.
Brand, Pure Concentrated.
Producer or jobber, false label.
Retailer, Kuch & Zink, LaMoure, N. D.
Of medium strength, but not properly labeled.

Lab. No. 507.
Brand, Jewell.
Producer or jobber, Stone, Ordean, Wells Co., Duluth, Minn.
Retailer, Deisem & Franks, LaMoure, N. D.
Of medium strength and probably contains some color.

Lab. No. 509.
Brand, Hiawatha.
Producer or jobber, Stone, Ordean, Wells Co., Duluth, Minn.
Retailer, Deisem & Franks, LaMoure, N. D.
Of good strength. Color (?)

Lab. No. 529.
Brand, Pure Concentrated.
Producer or jobber, J. H. Bell & Co., Chicago, Ill.
Retailer, Chas. Kupitz, Bismarck, N. D.
Of good strength. Color (?.)

Lab. No. 553.
Brand, Eddy's Extra High.
Producer or jobber, Eddy & Eddy, St. Louis, Mo.
Of good strength, but colored with caramel.

Lab. No. 590.
Brand, Standard.
Producer or jobber, Grand Forks Mercantile Co., Grand Forks.
Retailer, Geo. Wilder, Grand Forks, N. D.
Of medium strength, colored.

Lab. No. 634.
Brand, Seely's.
Producer or jobber, Seely Manufacturing Co., Detroit, Mich.
Retailer, H. G. Sprague, Grafton, N. D.
Of good strength.

Lab. No. 636.
Brand, Fort Snelling.
Producer or jobber, Foley Bros. & Kelly, St. Paul.
Retailer, J. LaMoure & Co., Neche, N. D.
Pure, but not very strong.

Lab. No. 647.
Brand, Standard.
Producer or jobber, Gillett's Chemical Works, Chicago, Ill.
Retailer, W. Crawford & Son, Neche, N. D.
Of good strength, but color questionable.

Lab. No 733.
Brand, Monarch.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, F. W. Manns & Son, Devils Lake, N. D.
A pure product of medium strength.

Lab No. 746.
Brand, Blue.
Producer or jobber, Seabury & Co., St Paul, Minn.
Retailer, Monson Bros & Co., Brocket, N. D.
Of medium strength, but probably colored.

Lab. No. 726.
Brand, Vanilla and Tonka.
Producer or jobber, Lakota Manufacturing Co., Chicago, Ill.
Retailer, A. D. Sprague, Devils Lake, N. D.
Colored with caramel.

Lab. No. 734.
Brand, Lagneb.
Producer or jobber, Griggs, Cooper & Co., St. Paul.
Retailer, F. W. Manns & Son, Devils Lake.
A poor product, but just as labeled.

Lab. No. 960.
Brand, McMurray's.
Producer or jobber, Wm. McMurray & Co., St. Paul.
Retailer, Colton Brothers, Grand Forks, N. D.
A very weak extract.

Lab. No. 988.
Brand, Extract of Vanilla, Vanillin, Coumarin and Fruit Color.
Producer or jobber, Foley Bros. & Kelly, St. Paul.

Lab. No. 1132.
Brand, Vanilla.
Producer or jobber, Foley Bros. & Kelly, St. Paul.
A good extract.

VANILLA EXTRACTS NOT PROPERLY LABELED AND ILLEGAL.

Lab. No. 51.
Brand, Fruit.
Producer or jobber, McCormick, Behnke & Co., St. Paul, Minn.
An artificial product of coumarin colored with caramel. Illegal.

Lab. No. 53.
Brand, Palace.
Producer or jobber, McCormick, Behnke & Co., St. Paul, Minn.
A product of good strength, but colored with caramel, therefore illegal.

Lab. No. 55.
Brand, Seal.
Producer or jobber, McCormick, Behnke & Co., St. Paul, Minn.
An artificial product colored with caramel, improperly labeled, therefore illegal.

Lab. No. 91.
Brand, Double Strength.
Producer or jobber, Nash Brothers, Grand Forks, N. D.
An artificial product of medium strength.

Lab. No. 94.
Brand, Blue Ribbon,
Producer or jobber, Nash Brothers, Grand Forks, N. D.
An artificial product made from vanillin and coumarin, colored with caramel. Not properly labeled, therefore illegal.

Lab. No. 134.
Brand, Triple.
Producer or jobber, Winston, Harper, Fisher & Co., Minneapolis
An artificial product of vanillin and coumarin colored with caramel. Improperly labeled, therefore illegal.

Lab. No. 135.
Brand, Climax.
Producer or jobber, Winston, Harper, Fisher & Co., Minneapolis
Largely an artificial product of coumarin or tonka and colored with what appears to be coal tar dye.

Lab. No. 145.
Brand, Robin.
Producer or jobber, J. H. Allen & Co., St. Paul, Minn.
An artificial extract. Illegal.

Lab. No. 183.
Brand, Puritan.
Producer or jobber, Park, Grant & Morris, Fargo, N. D.
Not made by official method.

Lab. No. 232.
Brand, No 2.
Producer or jobber, Griggs, Cooper & Co., St. Paul, Minn.
Of medium strength, but colored with caramel, therefore not legal.

Lab. No. 309.
Brand, Standard.
Labeled Vanilla and Tonka.
Producer or jobber, F. L. Frary & Co., Minneapolis, Minn.
An artificial product not properly labeled.

Lab. No. 310.
Brand, Belmont.
Producer or jobber, F. L. Frary & Co., Minneapolis, Minn.
An artificial product of vanillin with some tonka or coumarin.

Lab. No. 414.
Brand, Double Strength.
Producer or jobber, S. J. Vidger & Co., Fargo, N. D.
Retailer, R. N. Yarrow, Fargo, N. D.
An artificial extract of coumarin, colored with caramel.

Lab. No. 425.
Brand, Crown.
Producer or jobber, Fargo Mercantile Co., Fargo, N. D.
Retailer, P. J. Bergquist, Fargo, N. D.
It is artificial, largely coumarin and colored with caramel.

Lab. No. 461.
Brand, Anchor.
Producer or jobber, (no name) St. Paul, Minn.
Retailer, A. A. Burgess, Sheldon, N. D.
An artificial product of coumarin, colored with caramel.

Lab. No. 463.
Brand, Bengal.
Producer or jobber, name not given.
Retailer, A. A. Burgess, Sheldon, N. D.
Not pure. Not properly labeled and manufacturers name not given.

Lab. No. 471.
Brand, Gillett's Double.
Producer or jobber, E. W. Gillett, Chicago, Ill.
Retailer, C. S. Kratt, Sheldon, N. D.
Improperly labeled and colored.

Lab. No. 479.
Brand, Banquet.
Producer or jobber, Park, Grant & Morris, Fargo, N. D.
Retailer, Marion Grange, Sheldon, N. D.
An artificial product, mainly coumarin and colored with anilin.

Lab. No. 480.
Brand, Star.
Producer or jobber, Star Extract Co., Chicago, Ill.
Retailer, Marion Grange, Sheldon, N. D.
An artificial product colored with caramel.

Lab. No. 485.
Brand, Double Strength.
Producer or jobber, Ramharter Bros., Oakes, N. D.
Retailer, Ramharter Bros., Oakes, N. D.
Cartoon labeled 2 oz., and bottle labeled 1 oz. Contains coumarin and not properly labeled.

Lab. No. 513.
Producer or jobber, Hurly Bros., Forman, N. D.
Retailers, Hurly Bros., Forman, N. D.
Mainly artificial coumarin, colored.

Lab. No. 533.
Brand, Double Strength.
Producer or jobber, Atwood & Steele, Chicago, Ill.
Retailer, John Yegen, Bismarck, N. D.
Improperly labeled and misleading. Not double strength.

Lab. No. 541.
Brand, Gold Medal.
Producer or jobber, Bismarck Grocery Co.
Contains coumarin and colored with anilin.

Lab. No. 667.
Brand, Vanilla and Tonka.
Producer or jobber, F. L. Frary & Co., Minneapolis, Minn.
Retailer, Murphy, Holmes & Co., Neche, N. D.
An artificial product of coumarin and vanillin and colored with anilin. The top of the box was labeled "Vanilla.."

Lab. No. 694.
Brand, Robin.
Producer or jobber, J. H. Allen & Co., St. Paul, Minn.
Retailer, Devils Lake Co-operative Association.
A very weak extract, colored.

Lab. No. 704.
Brand, Pure.
Producer or jobber (not given), New York, Chicago.
Retailer, Nimmo Bros., Devils Lake, N. D.
An artificial product of coumarin, colored with caramel.

Lab. No. 748.
Brand, Seal.
Producer or jobber, Kenwood Preserving Co., Chicago, Ill.
Retailer, Edmore Mercantile Co., Edmore, N. D.
Colored, of low strength, and illegal.

Lab. No. 750.
Producer or jobber, Thompson-Taylor Spice Co., Chicago, Ill.
Retailer, Hutchins & Libby, Lakota, N. D.
Colored with anilin.

Lab. No. 782.
Brand, Booth's Vanilla and Tonka.
Producer or jobber, name not given.
Retailer, E. A. Perry, Fargo, N. D.
Outer wrapper of package labeled "Vanilla," type not uniform in size and not properly labeled. Manufacturer corrected label on notice from this department.

Lab. No. 870.
Brand, Vanilla.
Producer or jobber, John Sexton & Co., Chicago.
Retailer, box car merchant.
Good extract, but colored with coal tar dye.

Lab. No. 985.
Brand, Pure.
Producer or jobber, Hudson Mfg. Co., San Francisco, Cal.
Retailer, Greek-American Fruit Co., Grand Forks, N. D.
An artificial product of coumarin and vanillin colored.

Lab. No. 987.
Brand, Vanilla.
Producer or jobber, Foley Bros., & Kelly, St. Paul.
Contains vanillin and coumarin.

Lab. No. 1106.
Brand, Perfection.
Producer or jobber, Atwood & Steele, Chicago.
Retailer, Bruegger Mercantile Co., Williston, N. D.
Of good strength, but colored.

Lab. No. 1157.
Brand, Sexton's.
Producer or jobber, John Sexton & Co., Chicago.
Colored.

VINEGARS—PASSED.

Lab. No. 77.
Brand, Pure Apple Cider.
Producer or jobber, H. J. Heinz & Co., Pittsburg, Pa.
Retailer, Fred Blumer, Ellendale, N. D.
Specific gravity, 1.022; per cent acid, 4.95; solids, 2.82; ash, .25.

Lab. No. 78.
Brand, Pure Apple Juice.
Producer or jobber, S. R. & I. C. Motts, St. Louis, Mo.
Retailer, Fred Blumer, Ellendale, N. D.
Specific gravity, 1.020; per cent acid, 5.80; solids, 2.87; ash, .34.

Lab. No. 128.
Brand, N. Y. State Cider.
Producer or jobber, Wright-Clarkson Mercantile Co., Duluth, Minn.
Specific gravity, 1.022; per cent acid, 4.85; solids, 2.66; ash, .36.

Lab. No. 193.
Brand, Cider.
Producer or jobber, Genesee Fruit Co., Lansing, Mich.
Retailer, Geo R. Newell & Co., Minneapolis, Minn.
Specific gravity, 1.017; per cent acid, 5.127; solids 2.34. ash .28.

Lab. No. 322.
Brand, Apple Cider.
Producer or jobber, Jerse Norton, Duluth, Minn.
Specific gravity, 1.020; per cent acid, 4.70; solids, 2.77; ash, .29.

Lab. No. 323.
Brand, Cider.
Producer or jobber, O. L. Gregory, Paducah, Ky.
Retailer, Fargo Mercantile Co., Fargo, N. D.
Specific gravity, 1,020; per cent acid, 4.85; solids, 2.66; ash, .38.

Lab. No. 396.
Brand, Pure Cider.
Producer or jobber, Natz & Co.
Retailer, Fred Blumer, Ellendale, N. D.
Specific gravity, 1.019; per cent acid, 4.97; solids, 2.72; ash, .29.

Lab. No. 437.
Brand, Cider.
Producer or jobber, Clarkville Cider Co., Clarkville, Mo.
Retailer, M. T. Davis & Co., Lisbon, N. D.
Specific gravity, 1.020; per cent acid, 3.87; solids, 4.23; ash, .18.

Lab. No. 465.
Brand, Amazon Cider.
Made at Davenport, Ia.
Retailer, M. Gardner, Lisbon, N. D.
Specific gravity, 1.020; per cent acid, 4.77; solids, 3.08; ash, .10.

Lab. No. 566.
Brand, Pure Cider.
Producer or jobber, Bismarck Grocery Co.
Per cent acids, 5.25; solids, 2.79; ash, .33.

Lab. No. 599.
Brand, Elko Cider.
Producer or jobber, Wallace & Gregory, Paducah, Ky.
Retailer, Fargo Grocery Co., Fargo, N. D.
Specific gravity, 1.022; per cent acid, 4.77; solids, 2.97; ash, .36.

Lab. No. 725.
Brand, Cider.
Producer or jobber, M. A. Gedney, St. Paul, Minn.
Retailer, A. D. Sprague, Devils Lake, N. D.
Specific gravity, 1.019; per cent acid, 5.20; solids, 2.49; ash, .28.

Lab. No. 749.
Brand, Cider.
Producer or jobber, Winston, Harper, Fisher & Co., Minneapolis, Minn.
Retailer, Scott & Barrett Mercantile Co., Lakota, N. D.
Specific gravity, 1,015; per cent acid, 5.10; solids, 2.43; ash, .23.

Lab. No. 785.
Brand, Pure Cider.
Producer or jobber, Burdick & Lincoln, Fargo, N. D.
Specific gravity, 1.019; per cent acid, 4.70; solids, 2.45; ash, .50.

VINEGARS—LEGAL.

Lab. No. 298.
Brand, Cider.
Producer or jobber, unknown.
Retailer, T. E. Yerxa, Fargo, N. D.
Specific gravity, 1.0225; per cent acid, 4.58; solids, 3.92; ash, .45

Lab. No. 416.
Brand, Home.
Producer or jobber, Griggs, Cooper & Co., St. Paul, Minn.
Retailer, Pure Food Depot, Fargo, N. D.
Specific gravity, 1.020; per cent acid, 5.35; solids, 3.35; ash, 73.

Lab. No. 420.
Brand, Cider.
Producer or jobber, S. R. & J. C. Motts, St. Louis, Mo.
Retailer, Fulton's Market, Fargo, N. D.
Specific gravity, 1.015; per cent acid, 4.70; solids, 2.45; ash, .23.

Lab. No. 427.
Brand, Cider.
Producer or jobber, H. J. Heinz & Co., Pittsburg, Pa.
Retailer, W. B. Howland, Fargo, N. D.
Specific gravity, 1.020; per cent acid, 4.95; solids, 2.59; ash, .25.

Lab. No. 454.
Brand, Cider.
Producer or jobber, Clarkville Vinegar Co., Clarkville, Mo.
Retailer, C. Durgin, Sheldon, N. D.
Specific gravity, 1.020; per cent acid, 4.10; solids, 3.65; ash, .27.

Lab. No. 474.
Brand, Apple Cider.
Producer or jobber, S. R. & J. C. Motts, St. Louis, Mo.
Retailer, M. Grange, Sheldon, N. D.
Specific gravity, 1.020; per cent acid, 4.75; solids, 2.79; ash, .24.

Lab. No. 475.
Brand, Cider.
Producer or jobber, H. J. Heinz & Co., Pittsburg, Pa.
Retailer, M. Grange, Sheldon, N. D.
Specific gravity, 1.020; per cent acid, 5.50; solids, 2.70; ash, .40.

Lab. No. 494.
Brand, Cider.
Producer or jobber, Griggs, Cooper & Co., St. Paul, Minn.
Retailer, Klein & Sutmar, Oakes, N. D.
Specific gravity, 1.025; per cent acid, 5.87; solids, 3.30; ash, .47.

Lab. No. 499.
Brand, Cider.
Producer or jobber, H. J. Heinz & Co., Pittsburg, Pa.
Retailer, Cunningham & Lawrence, LaMoure, N. D.
Specific gravity, 1.020; per cent acid, 4.82; solids, 2.71; ash, .37.

Lab. No. 506.
Brand, Cider.
Producer or jobber, S. R. & J. C. Motts, St. Louis, Mo.
Retailer, Deisem & Franks, LaMoure, N. D.
Specific gravity, 1.020; per cent acid, 4.75; solids, 2.58; ash, .28.

Lab. No. 520.
Brand, Cider.
Producer or jobber, F. C. Johnson, Kishwaukee, Wis.
Retailer, McGillic Grocery Co., Mandan, N. D.
Specific gravity, 1'.020 ; per cent acid, 4.87 ; solids, 2.01 ; ash, .36.

Lab. No. 526.
Brand, Cider.
Producer or jobber, Bismarck Grocery Co., Bismarck, N. D.
Retailer, Jamison & Co., Mandan, N. D.
Specific gravity, 1.020 ; per cent acid, 4.80 ; solids, 2.61 ; ash, .41.

Lab. No. 567.
Brand, Cider.
Producer or jobber, Grand Forks Mercantile Co., Grand Forks, N. D.
Retailer, L. Stern, Larimore, N. D.
Specific gravity, 1.020 ; per cent acid, 4.85 ; solids, 2.76 ; ash, .23.

Lab. No. 576.
Brand, Cider.
Producer or jobber, Genesee Vinegar Co., Lansing, Mich.
Retailer, C. H. Howland, Grand Forks, N. D.
Specific gravity, 1.020 ; per cent acid, 4.62 ; solids, 2.37 ; ash, .32.

Lab. No. 580.
Brand, Cider.
Producer or jobber, Genesee Vinegar Co., Lansing, Mich.
Retailer, M. W. Hansen & Co., Grand Forks, N. D.
Specific gravity, 1.020 ; per cent acid, 4.60 ; solids, 2.77 ; ash, .33.

Lab. No. 588.
Brand, Cider.
Producer or jobber, Genesee Vinegar Co., Lansing, Mich.
Retailer, R. B. Griffith, Grand Forks, N. D.
Specific gravity, 1.017 ; per cent acid, 4.42 ; solids, 2.80 ; ash, .33.

Lab. No. 589.
Brand, Cider.
Producer or jobber, Genesee Vinegar Co., Lansing, Mich.
Retailer, Geo. H. Wilder, Grand Forks, N. D.
Specific gravity, 1.017 ; per cent acid, 4.50 ; solids, 2.88 ; ash, .33.

Lab. No. 591L.
Brand, Cider.
Producer or jobber, Genesee Vinegar Co., Lansing, Mich.
Retailer, K. M. Nass & Co., Grand Forks, N. D.
Specific gravity, 1.020 ; per cent acid, 4.72 ; solids, 2.70 ; ash, .40.

Lab. No. 592.
Brand, Cider.
Producer or jobber, H. J. Heinz & Co., Pittsburg, Pa.
Retailer, Johnson & McGowen, Grand Forks, N. D.
Specific gravity, 1.012 ; per cent acid, 5.22.

Lab. No. 598.
Producer or jobber, unknown.
Retailer, C. J. Calmer, Fargo, N. D.
Per cent acid, 4.25; solids, 2.31; ash, .26.

Lab. No. 635.
Brand, Cider.
Producer or jobber, F. C. Johnson, Kishwaukee, Wis.
Retailer, H. J. Sprague, Grafton, N. D.
Specific gravity, 1.017; per cent acid, 5.45; solids, 1.95; ash, .34.

Lab No. 744.
Brand, Pure Apple.
Producer or jobber, Barrett & Barrett, St. Paul, Minn.
Retailer, Pinkerton & Kellogg, Lakota, N. D.
Specific gravity, 1.018; per cent acid, 4.63; solids, 2.39; ash, .40.

Lab. No. 759A.
Brand, Cider.
Producer or jobber, O. L. Gregory, Paducah, Ky.
Retailer, R. M. Yarrow, Fargo, N. D.
Specific gravity, 1.018; per cent acid, 4.35; solids, 2.68; ash, .36.

Lab. No. 779.
Brand, Cider.
Producer or jobber, O. L. Gregory, Paducah, Ky.
Retailer, Grand Forks Mercantile Co., Grand Forks, N. D.
Specific gravity, 1.020; per cent acid, 4.87; solids, 2.93; ash, .36.

Lab. No. 798.
Brand, Cider.
Producer or jobber, Nash Bros., Grand Forks.
Specific gravity, 1.018; per cent acid, 4.77; solids, 2.68; ash, .11.

Lab. No. 805.
Brand, Cider.
Producer or jobber, M. A. Gedney Pickling Co., Minneapolis.
Specific gravity, 1,020; per cent acid, 4.80; solids, 2.22; ash, .27.

Lab. No. 806.
Brand, Cider.
Producer or jobber, W. A. Crawford & Son, Neche, N. D.
Per cent acid, 4.63; solids, 1.92; ash, .35.

Lab. No. 832.
Brand, Cider.
Producer or jobber, H. G. Sprague & Co., Grafton, N. D.
Specific gravity, 1.021; per cent acid, 4.95; solids, 2.72; ash, .38.

Lab. No. 838.
Brand, Cider.
Producer or jobber, Winston, Harper, Fisher & Co., Minneapolis.
Specific gravity, 1.019; per cent acid, 4.62; solids, 3.27; ash, .38.

Lab. No. 877.
Brand, Cider.
Producer or jobber, M. A. Gedney Pickling Co., St. Paul.
Specific gravity, 1.015 ; per cent acid, 4.45 ; solids, 2.51 ; ash, .43.

Lab. No. 947.
Brand, Cider.
Producer or jobber, Lenning, Brown, Wright & Co., Crookston.
Specific gravity, 1.0175 ; per cent acid, 5.64 ; solids, 2.54 ; ash, .46

Lab. No. 1046.
Brand, Cider.
Producer or jobber, M. A. Gedney Pickling Co., Minneapolis.
Retailer, J. E. Paulson, Hillsboro.
Specific gravity, 1.015 ; per cent acid, 5.25 ; solids, 2.45 ; ash, .41.

Lab. No. 1052.
Brand, Cider.
Producer or jobber, Farmer in New York.
Retailer, P. S. Peterson, Hillsboro.
Specific gravity, 1.017 ; per cent acid, 5.58 ; solids, 3.14 ; ash, .27.

Lab. No. 1098.
Brand, Cider.
Producer or jobber, Stone, Ordean, Wells Co., Duluth, Minn.
Specific gravity, 1.022 ; per cent acid, 5.55 ; solids, 3.73 ; ash, .28.

Lab. No. 1136.
Brand, Cider.
Producer or jobber, Barrett & Barrett.
Retailer, Melhouse & Ohnstad, Denbigh, N. D.
Specific gravity, 1.0155 ; per cent acids,4.90 ; solids, 2.07 ; ash, .32

Lab. No. 1156.
Brand, French.
Producer or jobber, L. A. Price, Bordeaux, France.
Retailer, Grand Forks Mercantile Co.
Specific gravity, 1.010 ; per cent acid, 6.87 ; solids, 3.58 ; ash, .04.

Lab. No. 1172.
Brand, Cider.
Producer or jobber, Farmers' Supply House, Fargo.
Per cent acid, 5.02 ; solids, 2.64 ; ash, .54.

Lab. No. 1199.
Brand, Cider.
Producer or jobber, Foley Bros. & Kelly, St. Paul.
Retailer, Jimeson & Olson, Cooperstown.
Specific gravity, 1.020 ; per cent acid, 5.12 ; solids, 3.32 ; ash, .27.

Lab. No. 1200.
Brand, Cider.
Producer or jobber, Foley Bros. & Kelly, St. Paul.
Retailer, Jimeson & Olson, Cooperstown.
Per cent acid, 6.25.

Lab. No. 1356.
Brand, Cider.
Producer or jobber, Gowan, Peyton, Twohy & Co., Duluth, Minn.
Per cent acid, 4.79; solids, 3.59; ash, .47.

VINEGARS—ILLEGAL.

Lab. No. 75.
Brand, Cider.
Producer or jobber, O. L. Gregory, Paducah, Ky.
Retailer, Patron's Exchange, Bottineau, N. D.
Specific gravity, 1.014; per cent acid, 5.15; solids, .56; ash, .17. Colored.

Lab. No. 76.
Brand, Prime Apple.
Producer or jobber, M. A. Gedney, St. Paul.
Retailer, Patron's Exchange, Bottineau, N. D.
Specific gravity, 1.011; per cent acid, 4.80; solids, .52; ash, .09. Colored.

Lab. No. 87.
Brand, Amazon Cider
Producer or jobber, unknown.
Retailer, Nash Bros., Grand Forks, N. D.
Specific gravity, 1.020; per cent acid, 4.55; solids, 2.99; ash, .09. Colored.

Lab. No. 95.
Brand, White Wine.
Producer or jobber, unknown.
Retailer, Nash Bros., Grand Forks, N. D.
Specific gravity, 1.022; per cent acid, 9.52; solids, .41; ash, trace

Lab. No. 112.
Brand, White Wine.
Producer or jobber, A. M. Richter & Son, Manitowoc, Wis.
Retailer, Mr. Grant, Fargo.
Specific gravity, 1.017; per cent acid, 9.45; solids, .35; ash, trace.

Lab. No. 140.
Brand, Pure Cider.
Producer or jobber, Knight, Stanley, Finney Co., Casselton, N. D.
Specific gravity, 1,011; per cent acid, 5.79; solids, 1.64; ash, .14. Colored.

Lab. No. 141.
Brand, Cider.
Producer or jobber, M. A. Gedney, St. Paul.
Retailer, Geo. H. Wilder, Grand Forks, N. D.
(Too small sample.) Per cent acid, 5.42; solids, 1.62; ash, .17. Colored.

Lab. No. 194.
Brand, White Wine.
Producer or jobber, unknown.
Retailer, Geo. R. Newell & Co., Minneapolis.
Specific gravity, 1,0125; per cent acid, 4.68; solids, 17; ash, trace.

Lab. No. 216.
Brand, Cider.
Producer or jobber, Cote Bros., St. Louis, Mo.
Retailer, Jurgens Bros., Fargo.
Specific gravity, 1.005; per cent acid, 4.85; solids, .48; ash, .02.
Colored.

Lab. No. 394.
Brand, Cider.
Producer or jobber, Karl Birk, Moorhead, Minn.
Specific gravity, 1.0175; per cent acid, 3.77; solids, 3.13; ash, .41.

Lab. No. 411.
Brand, Cider.
Producer or jobber, unknown.
Retailer, R. M. Yarrow, Fargo.
Specific gravity, 1.010; per cent acid, 1.75; solids, 2.22; ash, .27.

Lab. No. 415.
Brand, Cider.
Producer or jobber, unknown.
Retailer, Anderson & Co., Fargo.
Specific gravity, 1.010; per cent acid, 4.75; solids, .43; ash, trace.
Colored.

Lab. No. 424.
Brand, Apple Cider.
Producer or jobber, M. A. Gedney, St. Paul.
Retailer, P. J. Bergquist, Fargo.
Specific gravity, 1.014; per cent acid, 4.62; solids, .43; ash, .01.
Colored.

Lab. No. 443.
Brand, Cider.
Producer or jobber, Cote Bros., St. Louis, Mo.
Retailer, Cramer Bros., Lisbon, N. D.
Specific gravity, 1.015; per cent acid, 4.43; solids, .37; ash, .03.
Colored.

Lab. No. 455.
Brand, Cider.
Producer or jobber, unknown.
Retailer, Joseph Goodman, Sheldon, N. D.
Specific gravity, 1.010; per cent acid, 5.00; solids, .48; ash, .03.
Colored.

Lab. No. 469.
Brand, 45 Grains.
Producer or jobber, Winston, Harper, Fisher & Co., Minneapolis.
Retailer, C. S. Kratt, Sheldon, N. D.
Specific gravity, 1.015; per cent acid, 4.37; solids, .63; ash, .05.
Colored.

Lab. No. 486.
Brand, Cider.
Producer or jobber, Clarkville Vinegar Co., Clarkville, Mo.
Retailer, Ramharter Bros., Oakes, N. D.
Specific gravity, 1.015; per cent acid, 4.00; solids, 1.28; ash. 10.
Colored.

Lab. No. 502.
Brand, Cider.
Producer or jobber, unknown.
Retailer, Kuch & Zinck, LaMoure, N. D.
Specific gravity, 1.015; per cent acid, 5.11; solids, .68; ash, .11.
Colored.

Lab. No. 514.
Brand, Cider.
Producer or jobber, Cote Bros., St. Louis, Mo.
Retailer, Hurly Bros., Forman, N. D.
Specific gravity, 1.013; per cent acid, 4.75; solids, .48; ash, .05.
Colored.

Lab. No. 536.
Brand, Double Strength.
Producer or jobber, unknown.
Retailer, J. C. Swett, Bismarck, N. D.
Specific gravity, 1.020; per cent acid, 9.11; solids, .71; ash, .04.
Colored.

Lab. No. 538.
Brand, Cider.
Producer or jobber, M. A. Gedney, St. Paul.
Retailer, H. L. Michelson, Bismarck, N. D.
Specific gravity, 1.015; per cent acid, 5.12; solids, 1.51; ash, .14.
Colored.

Lab. No. 543.
Brand, Cider.
Producer or jobber, M. A. Gedney, St. Paul.
Retailer, Wm. O'Hara, Bismarck, N. D.
Specific gravity, 1.0175; per cent acid, 5.75; solids, .96; ash, .13.
Colored.

Lab. No. 547.
Brand, Cider.
Producer or jobber, unknown.
Retailer, Geo. Gussner, Bismarck, N. D.
Specific gravity, 1.015 ; per cent acid, 5.12 ; solids, .73 ; ash, .09.
Colored.

Lab. No. 557.
Brand, Cider.
Producer or jobber, unknown.
Retailer, box car, Geo. Meldrum.
Specific gravity, 1.009 ; per cent acid, 3.88 ; solids, .31 ; ash, .05.
Colored.

Lab. No. 570.
Brand, Amazon.
Producer or jobber, Nash Bros., Grand Forks, N. D.
Retailer, Larimore Packing Co.
Specific gravity, 1.020 ; per cent acid, 4.45 ; solids, 3.55 ; ash, .10.
Colored.

Lab. No. 577.
Brand, Amazon.
Made at Davenport, Ill.
Retailer, Salstad & Booker, Grand Forks, N. D.
Specific gravity, 1.020 ; per cent acid, 4.55 ; solids, 2.75 ; ash, .12.
Colored.

Lab. No. 597.
Brand, Cider.
Producer or jobber, Nash Bros., Grand Forks, N. D.
Retailer, W. F. Perry, Grand Forks, N. D.
Specific gravity, 1.012 ; per cent acid, 4.87 ; solids, .33 ; ash, .04.
Colored.

Lab. No. 630.
Brand, Cider.
Producer or jobber, M. A. Gedney, St. Paul.
Retailer, P. A. Jorgenson, Grafton, N. D.
Specific gravity, 1.016 ; per cent acid, 6.88 ; solids, .55 ; ash. .04.
Colored.

Lab. No. 657.
Brand, Cider.
Producer or jobber, M. A. Gedney, St. Paul, Minn.
Retailer, W. Crawford & Son, Neche, N. D.
Specific gravity, 1.009 ; per cent acid, 4.05 ; solids, .61 ; ash, .11.
Colored.

Lab. No. 658.
Brand, Cider.
Producer or jobber, O. L. Gregory, Paducah, Ky.
Retailer, W. Crawford & Son, Neche, N. D.
Specific gravity, 1.017 ; per cent acid, 5.80 ; solids, .82 ; ash, .12.
Colored.

Lab. No. 662.
Brand, Cider.
Producer or jobber, Red Cross Co., St. Louis, Mo.
Retailer, D. W. Young, Neche, N. D.
Specific gravity, 1.011 ; per cent acid, 4.58 ; solids, .19 ; ash, trace
Colored.

Lab. No. 671.
Brand, Cider.
Made at Davenport, Ia.
Retailer, Murphy, Holmes & Co., Neche, N. D.
Specific gravity, 1.012 ; per cent acid, 5.25 ; solids, .22 ; ash, .03.
Colored.

Lab. No. 718.
Brand, Cider.
Producer or jobber, Cote Bros., St. Louis, Mo.
Retailer, P. de Fiore, Devils Lake, N. D.
Specific gravity, 1.012 ; per cent acid, 5.43 ; solids, .36 ; ash, trace
Colored.

Lab. No. 786.
Brand, White Wine.
Producer or jobber, Burdick & Lincoln, Fargo, N. D.
Specific gravity, 1.018 ; per cent acid, 9.12 ; solids, .29 ; ash, trace

Lab. No. 786.
Brand, White Wine.
Producer or jobber, Burdick & Lincoln, Fargo, N. D.
Specific gravity, 1.018 ; per cent acid, 9.12 ; solids, .29 ; ash, trace

Lab. No. 1045.
Brand, Cider.
Producer or jobber, M. A. Gedney Pickling Co., Minneapolis.
Retailer, J. E. Paulson, Hillsboro, N. D.
Specific gravity, 1.015 ; per cent acid, 6.30 ; solids, 1.14 ; ash, .12.
Colored.

MISCELLANEOUS—LEGAL OR PASSED.

Lab. No. 85.
Brand, Selected Gherkins.
Producer or jobber, Nash Bros., Grand Forks.

Lab. No. 86.
Brand, Home Comfort Olives.
Producer or jobber, Nash Bros., Grand Forks.

Lab. No. 116.
Brand, Monitor Sweet Pie Pumpkin.
Producer or jobber, Lange Canning Co., Eau Claire, Wis.
Retailer, Mr. Grant, Fargo.

Lab. No. 173.
Brand, Peerless Plum Pudding.
Producer or jobber, Libby, McNeal & Libby.

Lab. No. 177.
Brand, Pork and Beans, Baked.
Producer or jobber, Libby, McNeal & Libby.
Lab. No. 247.
Brand, Booth's Baked Beans.
Producer, A. Booth & Co., Baltimore, Md.
Jobber, Griggs, Cooper & Co., St. Paul.
Lab. No. 248.
Brand, Oval Boston Baked Beans.
Producer, A. Booth & Co., Baltimore, Md.
Jobber, Griggs, Cooper & Co., St. Paul.
Lab. No. 249.
Brand, Boston Van Camp Pork and Beans.
Producer, Van Camp Packing Co., Indianapolis, Ind.
Jobber, Griggs, Cooper & Co., St. Paul.
Lab. No. 250.
Brand, Home Baked Beans.
Jobber, Griggs, Cooper & Co., St. Paul.
Lab. No. 258.
Brand, Bengal Sweet Potatoes.
Jobber, Griggs, Cooper & Co., St. Paul.
Lab. No. 265.
Brand, French Garden Spinach.
Producer, Potter & Wrightington, Boston, Mass.
Jobber, Griggs, Cooper & Co., St. Paul.
Lab. No. 268.
Brand, Home Pumpkin.
Jobber, Griggs, Cooper & Co., St. Paul.
Lab. No. 276.
Brand, Flat Rock Pumpkin.
Producer, at Flat Rock, Indiana.
Jobber, Griggs, Cooper & Co., St. Paul.
Lab. No. 278.
Brand, Oval Sweet Potatoes.
Producer, A. Booth & Co., Baltimore, Md.
Jobber, Griggs, Cooper & Co., St. Paul.
Lab. No. 303.
Brand, Home Asparagus.
Jobber, Griggs, Cooper & Co., St. Paul.
Lab. No. 330.
Brand, Cedar Sweet Potatoes.
Producer, W. L. Stevens & Brothers, Cedarville and Cape May, N. J.
Jobber, Foley Bros. & Kelly, St. Paul.
Lab. No. 645.
Brand, Leopard Sweet Pickles.
Producer or jobber, Geo. R. Newell & Co., Minneapolis.
Retailer, W. Crawford & Son, Neche, N. D.

Lab. No. 856.
Brand, Home Chow Chow.
Producer or jobber, Griggs, Cooper & Co., St. Paul.
Lab. No. 857.
Brand, Bengal Chow Chow.
Producer or jobber, Griggs, Cooper & Co., St. Paul.
Lab. No. 858.
Brand, Home Salad Dressing.
Producer or jobber, Griggs, Cooper & Co., St. Paul.
Lab. No. 859.
Brand, Bengal Chili Sauce.
Producer or jobber, Griggs, Cooper & Co., St. Paul.
Lab. No. 961.
Brand, Strained Honey.
Retailer, Soudrall Brothers, Warren, N. D.
Lab. No. 962.
Brand, Honey.
Retailer, Reuben B. Crouse.
Lab. No. 1017.
Brand, Honey.
Retailer, Chas. Kupitz, Bismarck.
Lab. No. 1043.
Brand, Randolph Golden Pumpkin.
Producer or jobber, Randolph Canning Co., Randolph, Wis.
Retailer, Fargo Mercantile Co., Fargo.
Lab. No. 1058.
Brand, U. S. Beets, California Strawberry.
Producer or jobber, U. S. Canning Co., Fredonia, N. Y.
Retailer, T. E. Yerxa, Fargo.
Lab. No. 1059.
Brand, Monarch Asparagus.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, T. E. Yerxa, Fargo.
Lab. No. 1086.
Brand, Clay City Pumpkin.
Producer or jobber, Clay City Canning Co., Clay City, Ia.
Retailer, T. E. Yerxa, Fargo.
Lab. No. 1114.
Brand, Libby's Premier Tomato Soup.
Producer or jobber, Libby, McNeal & Libby, Chicago.
Retailer, McKean & Probert, Wahpeton.
Lab. No. 1117.
Brand, Honey.
Retailer, Thos. Elliott, Grandin, N. D.
Lab. No. 1122.
Brand, No. A Beets.
Producer or jobber, Olney Brothers, Oneida, N. Y.

Lab. No. 1175.
Brand, Booth's Boston Baked Beans.
Producer or jobber, A. Booth & Co., Baltimore, Md.
Retailer, Farmers' Supply House, Fargo.

Lab. No. 1176.
Brand, Booth's Boston Baked Beans.
Producer or jobber, A. Booth & Co., Baltimore, Md.
Retailer, Farmers' Supply House, Fargo.

Lab. No. 1177.
Brand, Columbia Evaporated Cream.
Producer or jobber, Borden Condensed Milk Co., New York.
Retailer, Farmers' Supply House, Fargo.

Lab. No. 1179.
Brand, Economy Evaporated Cream.
Producer or jobber, Helvetia Milk Condensing Co., Highland, Ill.
Retailer, Farmers' Supply House, Fargo.

Lab. No. 1188.
Brand, Randolph Golden Pumpkin.
Producer or jobber, Randolph Canning Co., Randolph, Wis.
Retailer, Farmers' Supply House, Fargo.

Lab. No. 1192.
Brand, Monarch Asparagus.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, Fargo Grocery Co., Fargo.

Lab. No. 1198.
Brand, Van Camp's Vegetable Soup.
Producer or jobber, Van Camp Packing Co., Indianapolis, Ind.
Retailer, Fargo Mercantile Co., Fargo.

Lab. No. 1229.
Brand, U. S. Snowball Cauliflower.
Producer or jobber, U. S. Canning Co., Fredonia, N. Y.
Retailer, Lewis Vidger Loomis Co. Fargo.

Lab. No. 1276.
Brand, Pride of Rome Custard Pumpkin.
Producer or jobber, Olney Canning Co., Oneida, N. Y.
Retailer, Fargo Grocery Co., Fargo, N. D.

Lab. No. 1297.
Brand, Oval Cheese.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, Fargo Grocery Co., Fargo.

Lab. No. 1305.
Brand, Monarch Asparagus.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, Fargo Grocery Co., Fargo.

Lab. No. 1313.
Brand, Monarch Squash.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, Fargo Grocery Co., Fargo.

Lab. No. 1314.
Brand, Reindeer White Hominy.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, Fargo Grocery Co., Fargo.

Lab. No. 1319.
Brand, Gopher Sweet Potatoes.
Producer or jobber, Foley Bros. & Kelly, St. Paul.

Lab. No. 1321.
Brand, Shield Spinach.
Producer or jobber, J. S. Farren & Co., Baltimore, Md.
Retailer, Lewis Vidger Loomis Co., Fargo.

Lab. No. 1322.
Brand, Tomato Soup.
Producer, Franco-American Food Co., Jersey City Heights, N. J.

MISCELLANEOUS—ILLEGAL.

Lab. No. 1197.
Brand, Van Camp's Tomato Soup.
Producer or jobber, Van Camp Packing Co., Indianapolis, Ind.
Retailer, Fargo Mercantile Co., Fargo.
Colored with coal tar dye.

Lab. No. 1282.
Brand, Raspberry Jellycon.
Producer or jobber, E. S. Burnham Co., New York.
Retailer, Baldwin & Thompson, Fargo.
Colored with coal tar dye.

Lab. No. 1343.
Brand, Leaf Green.
Retailer, Fargo Grocery Co., Fargo.
Colored with coal tar dye.

Lab. No. 1377A.
Brand, Horseshoe Butter.
Producer or jobber, Bjoyge, Wangensler & Co., Lake Park.
Retailer, Fargo Grocery Co., Fargo.
Preservative, borax.

BEVERAGES—ILLEGAL.

Lab. No. 41.
Brand, Welch's.
Producer or jobber, Welch Grape Juice Co., Westfield, N. Y.
Preservative, salicylic acid.

Lab. No. 58.
- Brand, Concord Unfermented.
- Producer or jobber, Fremont Grape Juice Co., Fremont, Ohio.
- Retailer, Pure Food Depot, Fargo.
- Preservative, salicylic acid.

Lab. No. 321.
- Brand, Tanto Pure Extract of Malt and Hops.
- Producer or jobber, Barrett & Barrett, St. Paul.
- Retailer, H. H. Seelig, Leonard, N. D.
- Preservative, salicylic acid.

Lab. No. 815.
- Brand, Crab Apple Cider.
- Retailer, Park, Grant & Morris, Fargo.
- Contains sulphites.

Lab. No. 879.
- Brand, Cherry Cider.
- Producer or jobber, New England Bottling Co., Minneapolis.
- Contains coal tar dye.

Lab. No. 880.
- Brand, Orange Cider.
- Producer or jobber, New England Bottling Co., Minneapolis.
- Contains coal tar dye.

Lab. No. 881.
- Brand, Raspberry Cider.
- Producer or jobber, New England Bottling Co., Minneapolis.
- Contains coal tar dye.

Lab. No. 924.
- Brand, Old Blackberry Brandy.
- Producer or jobber, John Sexton & Co., Chicago.
- Retailer, box car merchant.
- Colored with coal tar dye.

Lab. No. 939.
- Brand, Peach Cider, Pure California.
- Producer or jobber, Los Angeles Fruit Cider Co., Los Angeles, Cal.
- Retailer, H. G. Sprague, Grafton, N. D.
- Colored with coal tar dye and an imitation product.

Lab. No. 979.
- Brand, Cherry Cider, Pure California.
- Producer or jobber, Los Angeles Fruit Cider Co., Los Angeles, Cal.
- Colored with coal tar dye, an artificial product, and contains benzoic acid.

MAPLE SYRUPS, SUGARS AND MOLASSES.

Lab. No. 223.
Brand, Beauce County, Quebec.
Producer or jobber, Griggs, Cooper & Co., St. Paul.
Cane sugar, 63.5 per cent; total solids, 70.98 per cent; ash, .086 per cent.

Lab. No. 225.
Brand, Uncle Josh.
Producer or jobber, Griggs, Cooper & Co., St. Paul.
Cane sugar, 65.7 per cent; total solids, 73.57 per cent; ash, .164 per cent.

Lab. No. 419.
Brand, Home Sap.
Producer or jobber, Griggs, Cooper & Co., St. Paul.
Retailer, Pure Food Depot, Fargo.
Glucose, 19 per cent; total solids, 60.14 per cent; ash, .68 per cent.

Lab. No. 575
Brand, Maple.
Producer or jobber, Leach, Gamble, Dexter & Co., Wahpeton, N. D.
Sucrose, 64.28 per cent; total solids, 70.65 per cent; ash, .178 per cent.

Lab. No. 604.
Brand, West Mooreland.
Producer or jobber, D. B. Scully Syrup Co., Chicago.
Retailer, Park, Grant & Morris, Fargo.
Sucrose, 61.42 per cent; solids, 68.49 per cent; ash, .18 per cent.

Lab. No. 605.
Brand, Fort Snelling.
Producer or jobber, Foley Bros. & Kelly, St. Paul.
Sucrose, 64.47 per cent; solids, 72.42 per cent; ash, .09 per cent.

Lab. No. 607.
Brand, Vermont.
Producer or jobber, Maneirro Yoe Syrup Co.
Retailer, box car merchant.
Cane sugar, 40 to 50 per cent; ash, .42 per cent.

Lab. No. 632.
Brand, Monarch.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, H. G. Sprague, Grafton, N. D.
One-third to one-half cane sugar; solids, 68.10 per cent; ash, 24 per cent.

Lab. No. 723.
Brand, Canada Maple.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, A. D. Sprague, Devils Lake, N. D.
Seventy-five per cent of added syrup; solids, 66.86 per cent; ash, .10 per cent.

Lab. No. 724.
Brand, Monarch.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, A. D. Sprague, Devils Lake, N. D.
Fifty per cent added cane sugar; solids, 65.04 per cent; ash, .19 per cent.

Lab. No. 757.
Brand, Pure Sap.
Producer or jobber, R. M. Dickinson, Cambridge, Vt.
Retailer, Leach, Gamble, Dexter & Co., Wahpeton.
Sucrose, 57.38 per cent; solids, 67.08 per cent; ash, .30 per cent.

Lab. No. 758.
Brand, Eastern Star.
Producer or jobber, made in Northumberland, Pa.
Retailer, Leach, Gamble, Dexter & Co., Wahpeton.
Sucrose, 61.94 per cent; solids, 70.55 per cent; ash, .14 per cent.

Lab. No. 759.
Brand, Canada Sap.
Producer or jobber, St. Paul Refining Co., St. Paul.
Retailer, Fargo Grocery Co., Fargo.
Sucrose, 72.59 per cent; solids, 72.59 per cent; ash, .10 per cent.

Lab. No. 839.
Brand, No. 1.
Producer or jobber, Maneirro Yoe Syrup Co., Chicago.
Retailer, Edwards Brothers, Fargo.
Solids, 70.18 per cent; ash, .18 per cent.

Lab. No. 840.
Brand, Maple.
Producer or jobber, Maneirro Yoe Syrup Co., Chicago.
Retailer, Edwards Brothers, Fargo.
Solids, 71.91 per cent; ash, .095 per cent.

Lab. No. 850.
Brand, Old Moose.
Producer or jobber, Arcadian Maple Co., St. Francios, Canada.
Retailer, Cramer Brothers, Lisbon, N. D.
Sucrose, 60.75 per cent; solids, 70.74 per cent; ash, .18 per cent.

Lab. No. 892.
Brand, Iowa Sorghum.
Producer or jobber, John Sexton & Co., Chicago.
Retailer, box car merchants.
Glucose, 40.30 per cent; solids, 79.10 per cent; ash, 1.75 per cent.

Lab. No. 898.
Brand, Raspberry Syrup.
Producer or jobber, John Sexton & Co., Chicago.
Retailer, box car merchant.
Contains coal tar dye, is an artificial syrup, colored and flavored with ethers.

Lab. No. 903.
Brand, Pure Maple.
Producer or jobber, W. W. Bardwell, Minneapolis.
Sucrose, 39.03 per cent; ash, .137 per cent.

Lab. No. 914.
Brand, New Orleans Molasses, Home Brand.
Producer or jobber, Griggs, Cooper & Co., St. Paul.
Retailer, Craigne & Gibbs, Minnewaukan.
Glucose, 19.50 per cent; sucrose, 17.06 per cent.

Lab. No. 915.
Brand, Pelican Bulk New Orleans Molasses.
Producer or jobber, National Molasses Co., St. Louis, Mo.
Retailer, Craigne & Gibbs, Minnewaukan.
Glucose, 51.53 per cent; sucrose, 24.92 per cent.

Lab. No. 930.
Brand, Maple.
Producer or jobber, St. Paul Refining Co., St. Paul.
Retailer, Rodenberg & Schwobel, New Rockford.
Sucrose, 62.57 per cent; solids, 69.93 per cent; ash, .45 per cent.

Lab. No. 931.
Brand, Puritan.
Producer or jobber, D. B. Scully & Co., Chicago.
Retailer, Pinkerton-Kellog Co. Lakota, N. D.
Sucrose, 61.49 per cent; solids, 73.61 per cent; ash, .13 per cent.

Lab. No. 932.
Brand, Northern Woods.
Producer or jobber, Berry-Maybrun Co., Chicago.
Sucrose, 42.80 per cent; ash, .081 per cent.

Lab. No. 933.
Brand, Raspberry Syrup.
Producer or jobber, John Sexton & Co., Chicago.
Retailer, box car merchant.
Colored with coal tar dye.

Lab. No. 934.
Brand, Molasses No. 2.
Producer or jobber, John Sexton & Co., Chicago.
Retailer, box car merchant.
Sucrose, 21.17 per cent; glucose, 16.16 per cent.

Lab. No. 936.
Brand, Climax Drips.
Producer or jobber, John Sexton & Co., Chicago.
Retailer, box car merchant.
Colored with coal tar dye.

Lab. No. 954.
Brand, Iowa Sorghum.
Producer or jobber, John Sexton & Co., Chicago.
Retailer, box car merchant.
Sucrose, 18.49 per cent; glucose. 41.77 per cent.

Lab. No. 966.
Brand, Pride of Ohio.
Producer or jobber, C. A. Cram, Warren, Ohio.
Sucrose, 57.11 per cent; solids, 62.10 per cent; ash, .46 per cent.

Lab. No. 967.
Brand, Maple.
Producer or jobber, C. A. Cram, Warren, Ohio.
Sucrose, 60.15 per cent; solids, 68.51 per cent; ash, .52 per cent.

Lab. No. 1019.
Brand, Log Cabin.
Producer or jobber, Towle Syrup Co., St. Paul, Minn.
Retailer, Geo. Gussner, Bismarck.
Sucrose, 67.76 per cent.

Lab. No. 1044.
Brand, Towle's Log Cabin.
Producer or jobber, Towle Maple Syrup Co., St. Paul.
Retailer, Fargo Mercantile Co., Fargo.
Sucrose, 67.31 per cent; ash, .215 per cent.

Lab. No. 1099.
Brand, Monarch.
Producer or jobber, Reid, Murdock & Co., Chicago.
Retailer, Anderson & Nelson, Park River, N. D.

CANNED AND POTTED MEATS.

A number of samples of canned and potted meats as put up by Libby, McNeal & Libby, Chicago, were submitted for analysis by Burdick & Lincoln, of Fargo. In each case the gross weights were taken, which included the can also, net weights of actual contents and in each sample was determined the water, ash, fat and proteids. In a few instances it will be noticed the undetermined matter appears to be unusually large. In most instances this is due to added products, spices, sweetening material and bread crumbs or cracker dust. The full data is shown in the following table:

	Gross Weight —Grams	Net Weight —Grams	Water—Per Cent	Ash—Per Cent	Fat—Per Cent	Proteid—Per Cent	Undetermin'd —Per Cent
Prime roast beef	519	386	60.90	4.08	13.27	21.75	.....
Hamburg loaf	329	227	60.53	2.39	13.93	19.75	3.40
Chipped dried beef	251.5	149.5	47.34	9.37	4.73	30.81	7.75
Jellied hocks	574	422.5	61.94	2.44	16.31	18.75	.59
Ox tongue	926	738	61.08	4.03	11.92	23.81	.....
Potted chicken	290	210	59.81	2.76	16.08	15.68	5.67
Potted ham	287	210	64.30	3.31	15.15	16.75	.49
Ham loaf	337	227	58.43	3.43	14.50	18.94	4.70
Corned beef	422.5	339.5	58.83	2.33	15.90	22.38	.56
Chicken loaf	320	210	59.16	2.30	15.67	17.06	5.41
Dried beef	270	166	46.85	10.63	4.79	30.81	6.92
Whole pigs feet	362	272	64.84	3.59	11.94	19.81	.....
Chili con carne	283	206	66.52	2.66	9.61	16.75	4.46
Beef loaf	350	226	61.70	2.60	13.48	18.43	3.79
Veal loaf	.....	.....	41.47	2.72	19.02	14.56	22.23
Vienna sausage	295.5	214.5	68.02	4.00	10.11	14.18	2.09
Hamburg steak	310	209.9	62.26	2.46	14.70	17.00	3.58
Cooked lich tongue	309	218	59.54	3.41	14.19	22.06	.80
Potted turkey	289	210	60.98	2.70	16.54	16.75	3.03
Boneless chicken	279.5	197.5	64.58	4.89	3.14	28.63	.....
Chicken tamale	305	228	68.81	1.31	10.54	8.75	4.59
Boneless turkey	281.5	196.5	65.19	1.30	3.61	26.94	2.96
Roast chicken	562	438	70.69	1.83	3.77	24.63	.....
Corned beef hash	286	205.3	68.90	2.55	6.46	13.13	8.86
Melrose pate	323	211.5	65.36	5.10	11.32	15.07	3.16

ANALYSES OF SPICES.

During the summer we requested one of the manufacturers of spices to furnish us with samples of unground commercial spices, also with spices produced from like samples ground and ready for the market. Below we give the analyses for these samples, believing that they will prove helpful to others who may have to deal with the commercial spices as found upon the market:

Name	Water	Ash	Fat		Crude fibre	Proteid Nx6.25	Nitrogen—Free Extract	Water Extract	Alcohol Extract
			Volatile	Fixed					
Cinnamon	7.41	3.34	2.48	1.69	22.65	3.70	58.73	.....	.....
Allspice	6.76	4.49	.....	7.46	20.47	4.88	55.94	.....	.....
Cloves	12.39	8.53	10.49	8.30	12.68	6.75	40.86	.....	.....
Black pepper	6.63	5.62	.....	8.18	12.26	12.06	55.25	.....	.....
Mace	2.81	2.70	5.59	21.62	2.42	10.31	54.35	.....	17.75
Cayenne pepper	7.97	5.41	2.06	20.30	20.41	14.87	28.98	17.06	22.61
Ginger	4.70	5.26	5.04	13.24	4.16	9.84	57.76	14.10	6.55
Nutmeg	8.65	2.28	1.76	21.76	7.12	9.15	49.28	.....	11.57
Cloves	14.58	6.80	8.26	16.83	10.23	6.47	47.83	.....	22.36
Cinnamon	7.75	3.21	2.78	2.27	16.90	3.66	63.43	.....	28.29
White pepper	9.52	1.23	1.50	6.87	3.69	12.56	64.63	.....	8.02
Mustard	5.62	5.55	0.87	15.68	5.50	39.34	27.44	37.22	23.06
Black pepper	9.47	3.97	1.99	8.04	12.40	14.68	49 45	.....	9.45
Allspice	9.01	4.53	5.65	6.20	24.72	7.06	42.85	.....	14.35

In addition to the above the manufacturers furnished me with a series of mixtures not infrequently used as adulterants for spices.

The bases for these mixtures were in most cases cereals so colored as to imitate very closely the pure spices themselves. In fact, in some instances the mixtures would readily be mistaken for the spices as one would see them in glasses, but of course they were void of any of the characteristic flavor or odors of the real spices. Below I give the analyses of this series of mixtures:

Mixture	Water	Ash	Fat		Crude Fiber	Proteid Nx6.25	Nitrogen—Free Ext'ct	Water Extract	Alcohol Extract
			Volatile	Fixed					
Cayenne	10.12	4.68	0.58	8.34	2.08	13.93	42.27	13.33	8.80
White pepper	9.00	1.95	0.15	3.28	1.08	16.78	67.76	.....	6.17
Black pepper	8.52	3.05	0.10	1.65	53.32	3.40	29.96	.....	2.19
Mace	5.69	3.25	1.69	6.26	0.81	13.31	68.99	.....	6.51
Allspice	6.09	4.47	1.19	8.38	20.43	16.25	43.19	.....	11.58
Nutmeg	8.97	2.69	0.39	7.08	12.64	10.38	57.85	.....	9.22
Cinnamon	7.20	3.05	0.54	0.86	24.12	7.50	56.83	.....	2.58
Cloves	6.19	7.91	0.64	7.97	21.78	14.56	40.95	.....	10.47
Ginger	9.27	3.28	0.58	2.85	1.58	17.25	65.19	22.42	5.78

ANALYSES OF TEAS.

A few samples of the commercial teas as found upon the market have been analyzed. In the table following Nos. 1 to 4 inclusive were commercial blends, while No. 5 is what is known as poppy tea. Below are given the results for these analyses:

	No. 1	No. 2	No. 3	No. 4	Poppy Tea No. 5
Water	3.13	2.34	4.02	6.13	5.89
Ash	5.80	6.19	6.41	6.45	5.73
Fat	11.28	6.34	6.09	6.33	4.94
Proteids	26.37	23.25	24.87	24.12	25.18
Crude fibre	10.63	11.12	9.66	10.48	8.69
Nitrogen free extract	42.79	50.76	48.95	46.49	49.57
	100.00	100.00	100.00	100.00	100.00
Nitrogen	4.22	3.72	3.98	3.86	4.09
Water soluble ash	2.33	3.39	3.56	3.63	3.94
Water extract	46.35	......	46.90	......	......

COURT CASES FROM JULY 1, 1903 TO JANUARY 1, 1904.

There have been but few cases of prosecutions since the law took effect July 1, 1903. Prosecutions have been begun against retailers only in those cases where it was evident the manufacturer or jobber was not taking steps to comply with the law. In the cases against I. N. Clark, representing George Meldrum (box car merchant), Chicago, for selling spirit vinegars as cider vinegars, a conviction was secured in the justice court, but an appeal was taken to the district court and the case is still pending.

In the case against the same party for selling adulterated maple sugar, a conviction was secured in the justice court, but the defendant appealed to the district court and the case is still pending, having been set for the January term of court.

In the case against A. P. Lewis, representing Pfohl & Smith, for selling candy adulterated, a conviction was had before Justice Geary at Fargo, but the defendant appealed the case to the district court and the case is still pending.

CASE 1.

State vs. S. P. Leslieyoung.

Charged with selling artificial strawberry extract colored with coal tar dye.

Justice court, Valley City.

Fined $25 and costs.

CASE 2.

State vs. S. P. Leslieyoung.

Charged with selling adulterated imitation strawberry jelly colored with coal tar dye and chemically preserved.

Justice court, Valley City.

Fined $25 and costs.

CASE 3.

State vs. I. N. Clark.

Charged with selling spirit vinegar for cider vinegar.

Justice court, Grand Forks.

Fined $100.

Appealed to district court.

CASE 4.

State vs. I. N. Clark.

Charged with selling maple sugar adulterated and not properly labeled.

Justice court, Grand Forks.

Fined $100.

Case appealed to the district court.

CASE 5.

State vs. L. Stern.

Charged with selling cherries colored with coal tar dye.

Justice court, Grand Forks.

Fined $25 and costs.

CASE 6.

State vs. L. A. Brooks.

Charged with selling adulterated tomato catsup.

Justice court, Grand Forks.

Fined $25 and costs.

CASE 7.

State vs. S. P. Leslieyoung.
Charged with selling Jamaica ginger colored with coal tar dye.
Justice court, McHenry, November 4, 1903, before Archy Lamont.
Fined $25.

CASE 8.

State vs. Geo. H. Fannon.
Charged with selling adulterated raspberry syrup containing coal tar dye.
Justice court, Grafton, October 31, 1903, H. A. Ball.
Fined $75 and costs.

CASE 9.

State vs. Geo. H. Fannon.
Charged with selling raspberry syrup adulterated with coal tar dye.
Justice court, Lakota, H. D. Fent.
Fined $50 and costs, $27; total, $77.

CASE 10.

State vs. R. B. Griffith.
Charged with selling adulterated canned strawberries.
Justice court, Grand Forks.
Fined $25 and costs.

CASE 11.

State vs. G. H. Wilder.
Charged with selling French cherries adulterated with coal tar dye.
Justice court, Grand Forks.
Fined $25 and costs.

CASE 12.

State vs. M. Colton.
Charged with selling tomato catsup adulterated with coal tar dye.
Justice court, Grand Forks.
Fined $25 and costs.

CASE 13.

State vs. W. F. Perry.
Charged with selling an artificial adulterated beverage colored with coal tar dye.
Justice court, Grand Forks.
Case continued.

CASE 14.

State vs. A. P. Lewis.
Charged with selling adulterated candy containing coal tar dye.
Justice court, Fargo.
Fined $25 and costs.
Appealed the case to the district court.

PURE FOOD LAW.

An Act to Prevent the Adulteration, Misbranding and Selling of Adulterated and Unwholesome Foods and Beverages, Prescribing a Penalty for the Violation Hereof, Providing for the Inspection and Analysis of Foods, Charging the North Dakota Experimental Station with the Duty Thereof, Charging the State's Attorney with the Enforcement Hereof and Making an Appropriation Therefor.

Be It Enacted, etc.

SECTION 1. ADULTERATING AND MISBRANDING FOODS AND BEVERAGES.—It shall be unlawful for any person, his agent or servant, or while acting as agent or servant of any other person or corporation, to manufacture for sale or offer for sale any article of food or beverage which is unwholesome or adulterated within the meaning of this act.

SEC. 2. WHAT CONSTITUTES ADULTERATION. Any article of food or beverage shall be considered as unwholesome or adulterated within the meaning of this act:

First. If it contains any form of aniline dye or other coal tar dye.

Second. If it contains formaldehyde, benzoic acid, sulphites, sulphurous acid or salicylic acid.

Third. If any substance or substances have been mixed with it so as to reduce or lower or injuriously affect its quality or strength, so that such article of food or beverage when offered for sale, shall deceive or tend to deceive the purchaser.

Fourth. If any inferior or cheaper substance or substances have been substituted wholly or in part for the article, so that the product when sold shall deceive or tend to deceive the purchaser.

Fifth. If any necessary or valuable constituent of the article has been in whole or in part abstracted.

Sixth. If it be an imitation of or offered for sale under the specific name of another article.

Seventh. If it be labeled or branded so as to deceive or mislead the purchaser.

Eighth. If it consists wholly or in part of a diseased, decomposed, filthy or putrid animal or vegetable substance.

PROVIDED, That an article of food or beverage shall not be deemed adulterated in the following cases:

First. If it be a compound or mixture of recognized food products and not included in definition sixth of this section.

Second. In the cases of candies and chocolates if they contain no terra alba, barytes, talc, chrome yellow or other mineral substances, or aniline dyes or other poisonous colors or flavors detrimental to health.

Third. If in the case of baking powders or any mixture or compound intended for use as a baking powder they have affixed to each and every box, can or package containing such powder or like mixture or compound, a light colored label upon the outside and on the fact of which there is distinctly printed with black ink and in clear, legible type the name and address of the manufacturers, the true and correct analysis, and in a form to be prescribed by the North Dakota Government Agricultural Experiment Station, of each and all the constituents or ingredients contained in or contributing a part of such baking powders, or mixture or compound intended for use as a baking powder.

SEC. 3. PENALTY FOR SO DOING. Any person violating any of the provisions of this act shall be deemed guilty of a misdemeanor, and shall for the first offense be punished by a fine of not less than twenty-five dollars or more than one hundred dollars, and all necessary costs, including the expense of analyzing such adulterated articles when said person has been found guilty under this act.

SEC. 4. DUTY OF STATE'S ATTORNEY. It shall be the duty of the state's attorney to prosecute all persons violating any of the provisions of this act when the evidence thereof has been presented by the North Dakota Government Agricultural Experiment Station as provided for in sections 7 and 8 of this act.

SEC. 5. THE NORTH DAKOTA EXPERIMENT STATION TO INSPECT AND ANALYZE FOODS AND BEVERAGES. The North Dakota Government Agricultural Experiment Station shall make analysis of food products and beverages on sale in North Dakota suspected of being adulterated, at such times and places and to such extent as it may determine, and may appoint such agent or agents as it may deem necessary, and the sheriffs of the respective counties of the state are hereby appointed and constituted agents for the enforcement of this act, and such agent or agents and sheriffs shall have free access, at all reasonable hours, for the purpose of examining into any place wherein it is suspected any article of food or beverage adulterated with any deleterious or foreign ingredient or ingredients exists, and such agent, agents or sheriffs upon tendering the market price of said article may take from any person, firm or corporation samples of any articles suspected of being adulterated as aforesaid, and the said Station may adopt or fix standards of purity, quality or strength when such standards are not specified or fixed by statute.

SEC. 6. CITIZEN MAY SEND SAMPLE OF FOOD OR BEVERAGE FOR ANALYSIS. Any citizen of the state may, by prepaying the transportation charges, send any article of manufactured food or food product, or beverage, in the original package, to said Station to be analyzed. And such article if not before analyzed shall be analyzed and included in the next report of the Station as provided for in section 9 of this act.

SEC. 7. FACTS, HOW TRANSMITTED. Whenever said Station shall find by its analysis that adulterated food products have been

on sale in this state, it shall forthwith transmit the facts so found to the state's attorney of the county in which said adulterated food product was found.

SEC. 8. CERTIFICATES AS EVIDENCE. Every certificate duly signed and acknowledged by the chemist of the North Dakota Government Agricultural Experiment Station at Fargo relating to the analysis of any food, food products or beverages shall be presumptive evidence of the facts therein stated.

SEC. 9. STATION TO MAKE ANNUAL REPORT. The said station shall make an annual report to the governor upon adulterated food products, and said report may be included in the report which the said station is already authorized by law to make to the governor, and in June and December of each year the said station shall furnish to the auditor of each county in the state a certified list of all adulterated foods, food products and beverages as found by such analysis, showing the name and brand of the article, the manufacturer, and the name of the injurious adulterant. The county auditor of each county shall cause the said list to be published in the official paper of such county. Said publication shall be made in July and January of each year and shall continue for two successive issues to be paid for by such county at the rate allowed by law for publishing the proceedings of the board of county commissioners.

SEC. 10. DUTY OF SHERIFF ON PRESENTATION OF COMPLAINT OF VIOLATION OF THIS ACT. COMPENSATION. It is hereby made the duty of the sheriff of any county of this state, on presentation to him of a verified complaint of the violation of any provision of this act, to at once proceed to obtain by purchase a sample of the adulterated food, food product or beverage complained of, and forward the same to the said Station for analysis, marking the package or wrapper containing the same for identification with the name of the person from whom procured, the date on which the same was procured, and the substance therein contained. For his services hereunder the said sheriff shall be allowed the same fees for travel as are now allowed by law to sheriffs on service of criminal process, together with such compensation as may be by the county commissioners of his county deemed reasonable, and all amounts expended by him in procuring and transmitting the said samples, which fees and amount expended shall be audited and allowed by the said commissioners and paid by his said county as other bills of said sheriff.

SEC. 11. APPROPRIATION. To carry out the provisions of this act, out of any money in the state treasury, not otherwise appropriated, the sum of fifteen hundred dollars is hereby annually appropriated to the said North Dakota Government Agricultural Experiment Station, which sum shall be paid in equal quarterly installments to the treasurer of the board of trustees of said station, upon the order of the state auditor, who is hereby directed to draw his order for the same.

SEC. 12. NO ACTION IN COURT. No action shall be maintained in any court in this state on account of any sale or other contract made in violation of this act.

SEC. 13. REPEAL. All acts and parts of acts inconsistent with the provisions of this act are hereby repealed.

Approved March 2, 1903.

HINTS FOR THOSE WHO WOULD COMPLY WITH THE PURE FOOD LAW.

The Lewis pure food law went into effect July 1, 1903, and it became the duty of the Government Agricultural Experiment Station at Fargo, North Dakota, to examine all food products offered for sale in the state, and when found to be adulterated to cause the offending party to be prosecuted for violation of the law.

By vote of the board of trustees of the Agricultural College, the chemist of the Experiment Station (E. F. Ladd) became the food commissioner for North Dakota on July 1, 1903, charged with the duty of enforcing the law in so far as it is made a part of the duty of the Station.

Retail grocers and all merchants dealing in food products, in making contracts for a new supply of goods, should specify that the same shall comply with the requirements of the Lewis pure food law. Some of the conditions of this law are as follows:

1. The foods or beverages must not contain prohibited chemical preservatives.
2. They must not contain coal tar or aniline dyes.
3. They must be labeled true to name.
4. If any essential constituent has been removed, the substance is adulterated.
5. If any substance has been added, so as to deceive or mislead the purchaser, the product is adulterated.
6. Mixed or compounded substances may be sold when properly labeled.
7. Vinegars must be sold under true names. Cider vinegar must be made wholly from apples.
8. The sheriffs in each county are deputies for guarding against the sale of adulterated food products in each county.
9. The Station is authorized to fix standards of purity, quality or strength.
10. Any citizen may have foods analyzed at the Experiment Station.
11. Twice each year county auditors must publish in the official paper a list of all adulterated foods found on sale in the state.
12. If adulterated goods are sold, no action can be maintained in any court in the state for the purpose of collecting outstanding bills for the same.

13. The state's attorney must prosecute all persons violating the law when evidence has been furnished by the Station.

14. Coffees must be pure, free from chicory, unglazed, not polished, and not extracted.

15. Extracts must be pure and what they claim to be.

16. Candies must not contain coal tar dye or harmful products.

17. Meats must not be colored or contain preservatives.

18. Sausages must not contain tainted or decomposed meats, and must not contain prohibited preservatives or coal tar dye.

19. The food commissioner, his agents, the sheriffs or their deputies shall have free access, at all reasonable hours, for the inspection of foods.

RULINGS.

The following rulings are those required under the state law, and are now generally accepted in other states:

BAKING POWDERS.

All baking powders to be sold in the state must be labeled in a conspicuous way and place with a name signifying the class or variety to which it belongs based on the name of the acid ingredient, and in form acceptable to the Experiment Station.

The following will be aceptable for the several forms: "This baking powder contains the following ingredients and none other." Then shall follow an enumeration of the constituents plainly expressed in the clearest and simplest terms. Acid sulphites are prohibited from use in any food product.

Buckwheat Flour.—Buckwheat flour must be the pure flour made from buckwheat. If it have other flour or self-raising ingredients mixed with it not injurious to health, it may be sold as "compounded buckwheat flour."

Candy.—Candy must be free from inert mineral matter. It must contain no terra alba, barytes, talc, chrome yellow or other mineral substance or aniline (coal tar dyes) or other poisonous colors or flavors detrimental to health.

Canned Goods.—Canned goods of all kinds must be free from coal tar dye or other harmful coloring matters. They must contain no formaldehyde, salicylic acid, benzoic acid, sulphurous acid or sulphites. If they contain other preservatives, the name of the preservative must be clearly indicated on a label.

Soaked Goods.—All soaked or bleached goods put up from products dried before canning shall be plainly marked, branded, stamped or labeled on each can or container with the words "soaked" or "bleached goods" in letters clear and distinct, in size not less than two line pica.

Chocolates and Cocoa.—Chocolate and cocoa, if made from the cocoa mass, sugar and glycerine, may be sold under the name "prepared cocoa" or "sweet chocolate." No other products can be sold under these names.

Coffee.—Coffee must be true to name. It must not be coated or polished to conceal inferiority. It must contain the extractive volatile matter natural to coffee. Compounds of coffee and chicory, or of coffee and other harmless substitutes allied to it in flavor and strength, and when not added as an adulterant, may be sold when properly labeled "coffee compounded." Imitations containing coffee cannot be sold as coffee compounds. They may be sold under coined names not intended to deceive.

Cream Tartar.—This compound must be pure. No compound may be lawfully sold as cream tartar.

Saccharin, or the so-called coal tar sugar, under whatever name used or sold, must not be used in any article of food or beverage offered for sale in North Dakota after July 1, 1904. This ruling will be enforced, and all goods found to contain the same will be declared illegal and in violation of the law.

EXTRACTS.

Artificial Extracts may be sold when labeled "artificial extracts," but, when the same natural extract is made from the fruit itself, an imitation product can be sold under the name of the fruit extract.

Lemon Extracts shall contain not less than 5 per cent of the pure oil of lemon dissolved in ethyl alcohol, and be free from any foreign color.

Vanilla Extract shall be made wholly from vanilla beans, and shall be free from any artificial coloring matter. Coloring matter added here must be deemed used for the purpose of concealing inferiority so as to deceive the purchaser.

When other flavoring substances are used, such as vanillin, coumarin or tonka, the extract should be labeled so as to show the purchaser its true character and not to deceive. The term "compounded extract of vanilla" is not a proper labeling.

The use of coloring matter of any kind is prohibited in this class of extracts.

JELLIES, SYRUPS, ETC.

Fruits, Jellies, Jams, Preserves, Etc.—These must be free from coal tar dyes, and must not be colored and labeled to imitate some other product so as to deceive the purchaser. They must be free from formaldehyde, salicylic acid, benzoic acid, sulphurous acid, sulphites or other harmful preservatives. If any preservative not prohibited is used, the name of the preservative must be plainly shown on a distinct label on each and every package.

Every Artificial Product made in part or in whole of glucose, dextrine, starch or other substances not injurious to health may be distinctly labeled "imitation fruit, jelly, jam or butter," but must not contain the name of any fruit so as to deceive or mislead the purchaser.

Honey.—Honey adulterated with glucose or other substances may be sold when labeled "adulterated honey."

Lard.—Imitation lard products must not be sold under the name of lard. "Compound lard" may be used on compounds made of lard and other substances.

Maple Sugar.—Maple sugar must be true to name. If added cane sugar is present, each and every package must be clearly and distinctly labeled so as to show its true composition.

Syrups.—Maple syrups must be the product produced from the sap of the maple tree.

Artificial Products intended to imitate maple syrups must not be sold under that name.

Molasses having mixed with it glucose may be sold as syrup, but in no case as molasses or molasses compound.

Glucose may be sold when labeled as glucose, corn syrup or under such coin name as not to deceive the purchaser. The product must be free from all sulphites and other bleaching agents.

MEATS, ETC.

Meats.—Meats of all kinds must not contain prohibited preservatives or coal tar dyes.

Sausage.—Sausages must be free from tainted or decomposed meat, must not contain coal tar dye or prohibited chemical preservatives.

Canned Fish and Meats must be free from chemical preservatives, and all fish products must be labeled true to name.

SPICES AND CONDIMENTS.

All spices must be pure. The mixture of foreign substances with any spice is adulteration. The extracting of the active principle of any spice, as extracting or removing the oil of cloves or the active principal of ginger, is an adulteration.

A Mixed or Imitation product must not be labeled so as to mislead or deceive the purchaser. The word "compounded" before or after the name of the spice is not a proper labeling for imitation or adulterated goods.

Vinegars.—All vinegar must contain at least 4 per cent of absolute acetic acid carrying in solution, if undistilled, extractives from the fruit, grain, vegetable or syrup used in their preparation. The term "vinegar" is limited to water solution of acetic acid derived from alcohol by fermentation.

Cider Vinegar must be made wholly from the fermented juice of the apple. Artificial or other vinegars fortified with another must not be sold as cider vinegar. The addition of apple pomace or apple jelly to the vinegar does not entitle it to be sold as cider vinegar.

Malt Vinegars must be made entirely from an infusion of malted grains. Every jug or retainer should be labeled with the class of vinegar contained therein.

The coloring of distilled and malt vinegars is in direct violation of section 2 of the food law, and when such vinegars are found to be so colored they will be classed as illegal and the retailers are liable to prosecution.

Whenever the words "artificial," "compounded," or "imitation," etc., are used, these words must be printed immediately preceding or following the word they are intended to modify, in the same type and equally prominent.

Tomato Catsup must be made from ripe tomatoes, uncolored and free from any foreign filler like starch or vegetable product.

STATEMENT

OF RECEIPTS AND EXPENDITURES FROM JULY 1, 1902 TO JULY 1, 1903.

RECEIPTS.

Received from U. S. Hatch Act March 2, 1887 .... $15,000

DISBURSEMENTS.

By salaries	$7,741.85	
Labor	3,056.31	
Publications	769.88	
Postage and stationery	376.25	
Freight and express	150.47	
Heat, light, water and power	777.46	
Chemical supplies	59.68	
Seeds, plants and sundry supplies	325.60	
Feeding stuffs	486.60	
Library	3.72	
Tools, implements and machinery	100.96	
Furniture and fixtures	50.12	
Scientific apparatus	375.72	
Live stock	440.00	
Traveling expenses	132.50	
Contingent expenses	66.75	
Buildings and repairs	86.13	
Total		$15,000

C. E. NUGENT,
Secretary.

BULLETIN No. 59

Trees and Fruit in North Dakota

BY C. B. WALDRON

TREES AND FRUIT IN NORTH DAKOTA.

The day of exploitation in North Dakota is rapidly passing and that of home building has taken its place. It is probable that no equal population has a larger proportion of home owners than has North Dakota. This fact, coupled with the important one that there is greater wealth per capita in North Dakota than in any other state, gives such conditions as should make possible a class of homes characterized by their comfort and attractiveness.

Since the earliest days of man trees have been considered a natural and fitting adornment and shelter for his home. In forests primitive man found his first shelter and protection. Trees were his necessity then, and the race can never rid itself of the instincts developed through the long ages of its evolution. We may admire the great expanse of prairie stretching away to the horizon, as we do the boundless ocean, but that does not imply that it includes the conditions making the most desirable homes. With the home are naturally associated the ideas of individuality, of snugness and, to a certain extent, seclusion, none of which can be attained if the place seems a part of the public domain.

In a region, too, like that of North Dakota, where the winds have fairly earned a reputation for strength and persistence, trees have a use as well as beauty. Passing from the shelter of the forest to open country on a cold, windy day one is made aware of all the difference between comfort and misery.

These facts are admitted by everyone, even by those that can offer no excuse for the bare dreariness and desolation that characterize the places where their lives are spent. To spend a lifetime without the presence of a single natural object about which the affections and memories can center, should not be an alluring prospect to

Attractive homes constitute an active and potent force in shaping civilized man. To busy men with their great amount of necessary work to be done these things are often overlooked, but for all that their importance is not less real.

and determining the character of society and its members, and after all there is nothing important but that.

There are certain elements in people that are accepted as evidences of civilization. These are established for the most part during the period of childhood and youth. Nothing on earth can take the place of a high state of civilization, and they make but a poor bargain who sacrifice the possibility of it for wealth or acres.

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To rear a generation amid surroundings that because of their dreariness and monotony depress and stultify the mind and imagination instead of quickening and enlivening it, is neither wise nor patriotic. It is not enough to say that we don't intend to do so. It is our duty and privilege to see that we do not. The individual experiences of the most of us bear testimony to the fact that no memories are more vivid or fondly cherished than those of the trees that once offered us protection and company. We feel somehow that their influence was good. Until human nature becomes something different than it is they will continue to exercise a most potent influence on the character of man.

Nations live or die with their forests, as the records of the world testify. Forests are the one great conserving element in nature. The winds and waters are constantly wasting and wearing away the fertile elements of the soil and hurrying them on to the sea, beyond the reach of man forever. By this process, long continued, whole regions have been made desolate and barren beyond reasonable hope of redemption, and even within the memory of living man large areas have been rendered useless through the same causes.

Aside from the secondary value of forests in preventing the waste and destruction of cultivated areas, the time has come when the forests themselves have a high money value. It is possible to grow five cords of wood per acre each year for an indefinite period upon millions of acres of our lands. With the present high price of timber, and that constantly increasing, this prospect alone should be an inviting one to the far sighted man.

Trees are grown for three purposes, for shelter, for ornament and for their timber or fuel value. About forty species can be grown in North Dakota. Among these are the white ash, white elm, red elm, rock elm, box elder, soft maple, hard maple, Norway maple, basswood, burr oak, cottonwood, white poplar, walnut, Russian wild olive, hackberry, white willow, birch and mountain ash.

SIZE AND COST OF TREES.

For the planting of groves, shelter belts, etc., seedling trees from one and one-half to two feet high will be found the most satisfactory. They may be procured from any nursery at a cost of from $3 to $5 per 1,000. Trees that have been transplanted in the nursery cost much more, from $10 to $20 per 100, and are more difficult to transplant.

METHOD OF PLANTING.

In planting seedling trees we ordinarily plow a deep furrow by going down and back in the same place, thus throwing the soil out in both directions. A line is then stretched along the furrow about a foot from the bottom supported by stakes at convenient distances. For further convenience the line may run through holes

in the stakes and may be marked at intervals of four feet to give distance in planting.

As the trees are unpacked they should be partially buried in moist earth at different points along the place of planting to keep them in good condition and make them easily accessible to the planters.

Three men are required for planting, one to pass along the line holding the trees in position, while a man on either side shovels the earth about the roots. After this process is completed it is very essential to pass along the row and tread the earth very firmly about each tree.

TIME OF PLANTING.

The trees should be set as early in the spring as the soil can be handled. Trees should be ordered early if one wishes to get good quality, and to be sure of having his orders filled. They may be ordered shipped on any date. If they arrive before the ground is ready they should be unpacked and spread out in a cool, shady place where they may be covered with damp earth or straw, or they may be heeled in the earth out of doors, covering the tops with straw to prevent the buds starting.

CULTIVATION.

Trees demand a mellow, moist soil, such as is found in the forest. They will not make a satisfactory growth, if indeed they live at all, in a hard, dry soil, especially if it be allowed to grow to grass and weeds. For these reasons the soil must be kept constantly cultivated until such time as the trees by their own shade supply the conditions under which they will thrive.

The number of years that a grove will require cultivation depends upon the character of the soil, the kinds of trees employed and the distance apart in planting. Quick growing trees like the box elder planted in moist, mellow soil two by four feet apart and kept well cultivated will make forest cover in three years.

On the other hand trees giving but little shade like the cottonwood will never make a forest cover sufficient to keep out the grass and weeds, no matter how planted.

VARIETIES AND ARRANGEMENT IN PLANTING SHELTER BELTS.

Trees for this purpose should be easily and quickly grown, perfectly hardy and of dense, compact habit. All of these qualities may not be found in any one variety, but a selection of three or four kinds may be made to include all the necessary qualities.

A single row of trees, excepting the evergreens, is not sufficient to make a good windbreak. It is found that three or four rows are required to make a perfect shelter. To give height to the windbreak, and that as soon as possible, a single row of cottonwoods,

or preferably Carolina poplars, should be planted as the north row of a windbreak running east and west and the west row of one running north and south. As they will not endure crowding, they should not be planted closer than eight feet apart.

This same distance should be maintained between the rows. The two middle rows should be made up of trees having a compact, bushy growth like the silver maple and box elder. These will endure shade and may be planted four feet apart.

The maple is a little harder to start than the box elder, but makes a better tree for the purpose in time. The two sorts planted alternately make an excellent combination.

The inner row may be of any compact growing kind, like the golden Russian willow or Russian wild olive, planted two feet apart. On high, dry soils, where the silver maple is not a success, the green ash may be substituted. Some of the best shelter belts on the station grounds are made up of elm, white ash and soft maple for the inside rows, leaving out the box elder, which is apt to make a poor growth after the first few years, except on very deep, moist soil.

For the first few years the windbreak will need to be kept well cultivated. When the trees begin to reach across the spaces between the rows, a heavy mulch of old straw may be applied to the ground to take the place of cultivation. By the time that is gone the trees will have the weed question settled for good. Trees in a windbreak should not be trimmed, but allowed to branch freely, clear to the ground if they will. To encourage this the trees are planted further apart than they should be in a grove.

LOCATION OF THE WINDBREAK.

The location of the windbreak will depend upon the conditions surrounding each place. It is a mistake to plant too close to the buildings. Enclose a space large enough to include the garden and fruit plantation, as well as to give a spacious yard about the buildings for planting ornamental things.

Windbreaks should be so placed that the snow which accumulates on the south side in the winter will not cause inconvenience. If there is some difficulty in doing this, a single line of willows planted a few rows to the north of the shelter belt will catch the snow and prevent its drifting through. The space between this row and the windbreak may be used for strawberries and bush fruits which are benefited by a snow protection in winter. Apple and plum trees so located would be broken down by the snows. Where the shelter belt bounds the lot on which the house stands, either at the sides or rear or both, it may be greatly improved in appearance by planting more or less irregular masses of shrubbery against it. These break up the rather formal and harsh appearance of the straight lines of trees into something more artistic and effective.

Plate 1—White Ash, Twelve Years Old. North Dakota Experiment Station.

As the trees get large a place without shrubbery looks desolate and cheerless compared with the comforting and homelike appearance that shrubs give.

The shrubs suited for this purpose will be given in another part of the bulletin.

TREE PLANTING FOR GROVES.

The primary purpose in planting a grove is to establish a wood lot on which to draw for supplies of fuel and posts as they are needed on the farm. Incidentally it may be made a very attractive feature of the farm and also serve for shelter.

The increasing scarcity of timber for all purposes is making the timber question a very important one. Timber is being removed from the forest areas of the country today about twice as fast as the forests can renew it. This of course will lead to a condition when growing timber will become a necessity.

Already timber growing on a commercial scale has been entered upon in some parts of the country. It is doubtful if timber growing will ever be established as a great commercial enterprise in North Dakota. At the same time the value of a wood lot on each farm, if properly grown, will in most cases more than compensate for the time and money required to grow it.

The work at this station has not been extended enough to answer in a practical way all the questions that might be asked concerning timber culture. We can only call attention to the experiments we are making and to what we have seen in other groves, including the belts of native timber.

Among the trees that will succeed well in groves are the willow, white ash, green ash, American elm, rock elm, soft maple, box elder, basswood, birch and white poplar. They are all native trees but will not of course all succeed equally well in all parts of the state. The green ash is found wherever trees will grow at all, and the elm is also widely distributed. The soft maple and the basswood seem to require moist soils, such as are found along river bottoms.

It will be noticed that the cottonwood and balm of Gilead, both native trees and rapid growers, have been left out of the list of trees suited for groves. The balm of Gilead may possibly be used to some extent, but the cottonwood is not to be considered. Planted singly it does well and is a useful tree, but it demands too much light and gives too little shade to make it a possible forest tree. It is also a well known fact among tree growers that other trees will not thrive in the vicinity of cottonwoods.

DISTANCE APART FOR PLANTING.

Trees suited for groves ordinarily do not make a good growth when planted some distance apart unless they are of considerable size when planted. A seedling elm or ash left to itself tends to

grow in the form of a bush and makes little progress in height. For this reason seedling trees of the varieties named must be planted close enough together to shade each other at the sides. This will prevent the growth of lateral branches and compel an upright growth.

Trees in a grove to be of any value should be tall and straight. By being forced to stretch up to get the light they naturally become so.

Two feet between the trees in a row is about the right distance at first. The rows may be far enough apart to cultivate easily with a two-horse team, or about eight feet. The soil should be in such a shape that it may readily be cultivated. The method of planting has alreadv been described.

Trees like the box elder, making a quick growth but being short lived, are used simply as nurse trees to get the others started. They shade the ground quickly, and in that way are a benefit to the other trees. The permanent trees are those like the elm, ash and basswood. Every other tree should be a nurse tree. Between these the permanent trees may be distributed as suits the fancy of the planter. The larger growing tiees like the elm and white ash should not be nearer than eight feet apart in the row. The green ash makes a quicker growth than the white ash but does not continue it so long. It may be used as a semi-permanent tree planted half way between the larger kinds. Its timber is valuable for posts or fuel.

CULTIVATION.

While small the trees may be cultivated the same as corn with an ordinary two-horse cultivator. Another excellent tool for this purpose is the Acme harrow. This cuts about seven feet wide. It is a good weed destroyer, and leaves the soil well pulverized and in good shape to retain the moisture. With it one can cultivate an acre of trees an hour.

Until the trees begin to shade the ground they should be cultivated frequently, about once in ten days or two weeks and especially after every rain. In ordinary seasons the cultivation should continue until late in the fall, but in seasons of excessive rainfall the cultivation may stop late in the summer to give the wood a chance to ripen for winter.

In dry seasons cultivation is more imperative than in wet. As the trees become large enough to shade the ground, which they will do very quickly if well tended, less cultivation will be required, and after four or five years they will need but little. In most cases it can be done away with entirely, and a good mulch of old straw will meet all requirements.

Plate II—Silver Maple Hedge. North Dakota Experiment Station.

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PRUNING.

During the first and second years the trees will be benefited by cutting off the side branches to keep them from forking and to force an upward growth. After that they should shade each other enough so that side branches will not form. This work may be done in the spring or summer, not later than July, or in the late fall. Pruning late in the summer forces a late growth that will not mature before winter.

THINNING.

Left to themselves, no matter how thickly planted, the stronger trees gradually outtop the weaker ones and thus nature does her own thinning. On can save time, however, and get better results if this process is not left wholly to nature. When the trees show evidences of being crowded a part of them should be removed. These will naturally be the nurse trees that have served their purpose in getting the others started. If desired for planting elsewhere they may be dug out late in the fall and heeled in for winter in some spot where the snow will drift over them, or they may be dug out in the spring and planted at once when needed.

These trees being nursery grown should be tall and straight and well suited for street or lawn planting. They have a market value of about $10 per 100, an acre producing 1,360 trees where none are missing. This still leaves the trees standing four by eight feet apart, and in time these will need further thinning.

LIST OF TREES FOR TIMBER PLANTATION.

White Ash.—The wood of this tree is strong and durable. It is used where strength and elasticity are required, as in fork handles, whiffletrees, the manufacture of vehicles, farm machinery, etc. It it fairly durable when used as posts and has a high fuel value. The wood of the green ash has much the same qualities. Both of these trees are slow to leave out in the spring and shed their foliage early in the fall. For that reason they should be planted with other sorts not having this defect, in order to better prevent the growth of grass and weeds among the trees.

American Elm.—This is of little money value to the farmer except for fuel. The wood is not durable in contact with the soil. Its value is chiefly as a shade tree.

Basswood.—The timber of this tree has no special value except for fuel until such time as the trees are large enough to be made into lumber. It is then in demand where a light, stiff material is required, as in the manufacture of trunks, etc.

Silver Maple.—This is also known as white maple and soft maple. Its only timber use for the farmer is for fuel. It should not be planted singly, as it is easily broken by the winds. It is very ornamental and holds its foliage well. Its chief use is as a shelter and nurse tree.

White Willow.—This tree grows rapidly and makes a large amount of fuel in a few years. When well seasoned it makes a post that is fairly durable. Its hardiness and the ease with which it is started make it one of the most valuable of trees for prairie planting.

Golden Russian Willow.—Has much the same habit as the white willow but grows faster, at least when young. Is more especially suited for hedges and shelter belts.

Box Elder.—A quick growing, short lived tree. The timber has no value except for fuel. Its chief value is as a nurse tree and for lawn and street planting. Unless the top is kept thinned out it becomes scraggy and makes a poor growth. With heavy pruning from the time it is a young tree it grows into a symmetrical tree that makes a dense shade.

Burr Oak.—This is the only native oak. Its timber is valuable for many purposes, but its growth is too slow to make it a profitable tree for planting.

White Poplar.—A native tree growing in dense groves along the streams and in the northern part of the state. Grows rapidly for the first fifteen years. Will produce as high as ninety cords of wood per acre with eighteen years' growth. As it springs up thickly from suckers, it reproduces itself without planting. On this account it is probably one of the best fuel trees than can be grown.

Hackberry.—A native tree having something of the character of the elm to which it is botanically related. While not attaining the size of the elm, it is in some respects a better tree, growing more symmetrically and thus requiring less attention. It is rather better adapted for lawn and street planting than for timber plantation, though it succeeds well there.

American White Birch.—When of sufficient size the birch is made into lumber for the manufacture of furniture and various wooden implements. The chief use of small trees, such as are found native in the northern part of the state, is for fuel. This tree makes a fairly rapid growth, and its extreme hardiness and striking beauty lead to its being largely planted.

STREET AND LAWN PLANTING.

The interest in tree planting to improve the appearance and comfort of our towns and villages is being made manifest in many localities. At other points little or nothing has been done, and as a result their cheerless and forlorn aspect makes a sorry comparison with the beauty and attractiveness of their more enterprising neighbors. All of the timber trees that have been named are more or less suited to street and lawn planting, and in addition there are other smaller sorts that are useful for ornamental purposes only.

Throughout the middle and northern states the elm is usually looked upon as the best tree for street planting, though at the

Plate III—Shelter Belt of White Spruce. North Dakota Experiment Station.

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present time the box elder and the cottonwood are more extensively used in North Dakota. The elm combined with these, or rather with the Carolina poplar and box elder, makes a good combination. On the outside of the walk plant the Carolina poplar and elm alternately, leaving twenty feet between the trees. On the inside of the walk plant the box elders opposite the poplars. At the end of fifteen or twenty years the poplars should be removed, leaving the elm and box elder alternating on opposite sides of the walk with a space of forty feet between the trees of each row and a tree for every twenty feet along the walk.

It is the ordinary practice to set trees much closer than this and never remove them. Some people are too kind hearted to cut down a tree. Others have still kinder hearts and cut down some that the remainder may grow into natural and perfect shape. Such trees live longer and, unless one takes pleasure in deformed things, look better.

Trees for street planting should be nursery grown if possible, and in all cases should be headed high. The trunks should be straight and two inches or more in diameter, excepting the Carolina poplars, which may be smaller. It is difficult for a very small tree of most varieties to grow tall and symmetrical when set in an open and exposed place. They should be grown in the nursery long enough to give them an established form and character.

PRUNING STREET TREES.

The butchery that it has seemed fitting to perform on street trees to keep them within bound just at a time when they should be growing into their greatest beauty could be obviated by giving them the proper attention when young.

Branches of old trees are pretty sure to droop and get in the way unless headed well up from the ground and kept that way by cutting away the lower branches while they are small, long before the trees seem to need it. This process increases the rate of growth of the upper and outer branches and gives what is needed, a tall spreading tree.

The elm has a tendency to an irregular or even sprawling habit of growth. This should be corrected by cutting back the extending branches, making the top symmetrical. The box elder should be kept well trimmed from the bottom from the time it is planted, and its growth will be faster if the interior limbs are removed before they become too thick. Trees with open tops like the cottonwood may be improved by keeping the tops cut back, thus making them more dense. The hackberry requires little or no pruning except to keep the lower branches cut as it develops in height. The typical street tree is one headed high enough not to interfere with traffic and to allow an open view between the house and street, under the trees. The general effect is also infinitely better if the pruning be done gradually as the tree grows instead of waiting till

one final day and then cutting off most of the branches, leaving crippled, crooked trunks surmounted by a pinched and straggling top.

ORNAMENTAL TREES AND SHRUBS.

The average lawn requires but few large trees, and these will ordinarily be at the sides and rear. Small, compact trees and shrubs give a better effect, and these should be arranged so as not to break up the open effect in front nor interfere with good views from the house.

Planting in irregular masses about the boundaries of the place and close against the house, leaving a free, open expanse of lawn between, will give the best results.

We have over thirty shrubs growing upon the station grounds and there are very many more suited to this latitude. There are several trees, like the cut leaved weeping birch, mountain ash, blue spruce and Black Hills spruce, that are especially adapted for lawn planting.

The Cut Leaved Weeping Birch easily stands at the head of all trees for planting upon the lawn. It grows rather rapidly while young but never attains very great size. It should be planted where other trees will not crowd it and where the branches may be allowed to droop to the ground. On account of its rich and elegant appearance it must be planted very sparingly, not more than two or three trees upon small grounds.

The Mountain Ash is another tree of great beauty. Its rich, dark foliage and bright red berries give it a very striking appearance. It is perfectly hardy but somewhat liable to sunscald, making protection of the trunk necessary in very exposed places. Like the birch it should be planted sparingly.

The Colorado Blue Spruce is the most striking of all evergreens on account of its silvery blue color. It is hardy in northern latitudes, but should have some protection against south winds, as indeed all evergreens should. It grows into symmetrical form and because of its acknowledged beauty should be generally planted.

The Red Cedar is one of the hardiest of the evergreens, growing wild in the western portion of the state. It starts rather slowly, but soon grows about a foot a year, becoming a compact and very ornamental tree.

The Black Hills Spruce is a form of the white spruce, but often closely resembles the blue spruce in color. It is very hardy and desirable.

Of ornamental shrubs the common and Persian lilac, snowball, tartarian honeysuckle, barberry, red dogwood, burning bush, ninebark, spirea (*Van Houtii*), juneberry, chokecherry, buckthorn, whitethorn, buffalo berry, golden currant, elderberry (black), red berried elder, sumac and the rugosa roses are all easily grown and very ornamental.

Plate IV—Hedges of Russian Willow. North Dakota Experiment Station.

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They should be grown for the most part in clumps or masses close about the porch or sides of the house to relieve the bareness of the building, and also where walks diverge or curve, or against the larger trees to hide the trunks. Shrubs give a rich and soft aspect that cannot be attained by other forms of planting.

HEDGES.

The plants now growing at the station for hedge purposes are the buffalo berry, wild plum, silver leaf (*Eleagnus argentea*), caragana, buckthorn, Russian wild olive, tartarian honeysuckle, silver maple, golden Russian willow and red cedar.

They may be divided into two classes, those used for fences against stock and the strictly ornamental hedges, though of course all may be made more or less ornamental.

The golden Russian willow is the one we have planted most extensively probably because it costs less to get it started. It grows readily from cuttings, is very ornamental both in summer and winter, and when required grows large enough to make a fine shelter and heavy enough to protect against stock.

The cuttings are set early in the spring about a foot apart and in soil that can be kept cultivated. The cultivation should continue along the sides of the hedge for three or four years. After the plants are two or three years old they should be cut back to the ground so they will make a dense growth. The other plants making heavy, stout hedges are the buffalo berry, wild plum, Russian wild olive and silver maple. These are not grown from cuttings, but from young plants. In some respects the buffalo berry makes one of the best hedges. It is of course perfectly hardy, is free from disease or insect attack, well armed with formidable spines, holds its foliage till very late in the season, and is very ornamental. The fruit is also valuable in making jelly.

When grown in cultivated ground it has the habit of sending up suckers about the old plants. While these may be easily kept down, yet the habit may be considered a slight objection to the plant. When the land alongside is seeded down the suckers do not appear.

The wild plum suckers worse than the buffalo berry, but as with that plant, when the land has once been seeded down, the tendency to sucker is not serious.

Both of these plants require less attention in the way of trimming than the willow, but on the other hand do not grow as fast. They should also be planted about a foot apart and kept cultivated till they are well established. The silver maple is a stronger grower than any of the plants mentioned and makes an excellent hedge. It requires, however, a deep, moist soil and is not generaly considered a success outside the Red river valley. Where a hedge is required large enough to afford a shelter it is probably the best plant to be found in soils where it will grow.

In starting a maple hedge seedlings of course will be used. The may be set one and a half or even two feet apart. If allowed to do so they will naturally grow in the form of a bush, which makes them the more valuable for hedge purposes. The silver maple is not so easy to start as the willow, but is rather more thrifty after the first few years, as the interior branches stand shade better than those of the willow.

The Russian wild olive has been tried but two years with us and in a small way at that. It is very highly spoken of as a hardy, drouth resisting plant. The tree growers in western Nebraska have placed it at the head of their list. It resembles the buffalo berry in the color of its foliage, but is a more rapid grower and more showy. The plants on the station grounds grew two feet last season. It has not winter killed with us, though Mr. Uelland at Edgeley reports the tops having killed back a little with him. It holds its foliage till winter, does not sucker, grows into good form for hedges and is well armed with stout spines. We shall plant it largely next spring. If it proves hardy it ought to make a valuable hedge about school grounds and similarly exposed places.

ORNAMENTAL HEDGES.

All of the other hedge plants named are valuable for ornamental purposes only, though some of them have been sold by tree peddlers under the name of "Siberian hedge," etc., with the assurance that they will turn stock in three years. It is impossible to tell which is the best of these as no one is the best for all purposes. The buckthorn makes an excellent hedge and in time will afford some protection against dogs and stock. It has rich, dark green foliage that remains on till late in the fall. It requires little attention, does not sucker, and makes a dense growth. It is slow about getting started; but does well when once established.

The caragana starts readily and will make a fairly good hedge in three years. The foliage is light green, and while very beautiful in early summer is apt to rust and get dingy later in the season. It it very hardy and a valuable plant.

The silver leaf is a native of the state and is sometimes known as the badger bush. It grows readily into a low, pretty hedge, but suckers badly.

The tartarian honeysuckle is about the best plant, all things considered, for an ornamental hedge. It is perfectly hardy, a profuse bloomer, starts readily, is not subject to disease or insect attacks, and will succeed with any reasonable treatment.

It will grow eight or ten feet high as a dense, stout bush, or may be kept trimmed to any height. The red cedar is probably our surest evergreen and is well adapted for hedges. Trees obtained from Minnesota seem perfectly hardy. It is not a rapid grower, though last season our trees made a growth of about a foot. It is of course an ornament the year round, and for that reason

Plate V—Young Plum and Apple Trees. North Dakota Experiment Station.

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should appeal to those wanting something unusually fine if they are prepared to give it the attention it demands till it becomes established. The plants of the red cedar should be set about two feet apart, of the others named about one foot.

TRIMMING HEDGES.

For this purpose a straight corn knife kept well sharpened is used. The straggling branches are lopped off by quick upward strokes. The trimming may be done any time in the summer, not later than the last of July, or the last thing before winter sets in. Trimming in late summer causes a new growth to start that is likely to be winter killed. The older branches in a hedge as they begin to get scraggy may be cut out entirely, and sometimes it is necessary to cut the whole hedge back to the ground to get a new, healthy growth.

No one feature on our own grounds is more admired than the hedges, and considering the ease with which they are grown and the necessity for some sort of boundary about the place for shelter and protection, there is no reason why they should not be universally planted.

FRUIT CULTURE.

The success that the Experiment Station and many private growers have had with small fruits has led to numerous inquiries as to the methods employed and the varieties that may be recommended. We do not advise anyone to attempt the cultivation of fruits without providing for their shelter by means of windbreaks. This is particularly true of strawberries, that suffer greatly through the effects of drying south winds, and applies in a greater or less degree to all fruits.

The shelter should be along the south as the destructive winds come from that quarter. For the location of the fruit plantation select a north or northeast slope where it can be obtained, and at any rate avoid a south or west one.

Provision must also be made such that water will not remain on the ground for any length of time during the spring thaws or after heavy rains.

Where the rainfall is not heavy, as in North Dakota, one should avoid a sandy or gravelly soil. In mellow soil the roots of strawberries extend down two and one-half feet and of the other fruits probably as deep. From this fact will be seen the necessity of providing a place having a deep, mellow soil free from gumbo and of course from alkali.

Any soils excepting those naturally too light will be benefited by a deep plowing and subsequent firming down with a harrow. We have not found it necessary or even profitable to fertilize the soil at the Station on which fruit is growing. Of course soil having a much less degree of fertility would be benefited by plowing under

a good dressing of well-rotted stable manure. Unless it is so thoroughly decomposed as to mix readily with the soil it will be better not to use any. It is generally recommended that currants and gooseberries have heavier soil than raspberries, and while that rule may be successfuully applied in localities having variable soil and a heavy rainfall it is sufficient to say under our own conditions that the deepest and best soil should be selected on which to grow all of our fruits. While there are undoubted difficulties to be encountered in growing fruit in North Dakota, still some of the fruits may be made to do unusually well here, and considering the high prices to be obtained others are quite as profitable here as in more favored localities.

PLUMS.

The plum is the most valuable fruit for North Dakota and doubtless will be for years to come. Wild plums of many types, some of them of excellent quality, are found growing in all parts of the state. The demand for these now far exceeds the supply, and the general cultivation of the plum should begin at once.

Many of the thickets contain trees bearing fruit of good quality, and these may be transplanted to the home garden with profit. A hundred trees thus selected twelve years ago have been growing upon the Station grounds since, and have been the source of hundreds of seedlings that are now coming into bearing. In this way improved varieties may be obtained that are of course well suited to the different localities in which they are grown. In this way also one may be sure of securing a variety sufficiently early to ripen before frosts, as all of the sorts of the American plum brought from other localities will not. There are now over a hundred varieties of the same plum that is found growing wild in our state offered for sale.

A few of these are growing at the Station, the most of them just coming into bearing. These were only partially protected on the south, and last fall a violent gale coming just after an excessive fall of rain blew them over. They were then removed to a better protected location. This circumstance shows that it is quite necessary to provide good shelter, though it must not be placed so as to allow the snow to drift over the trees.

The trees may be further protected by planting them close together, as close as six by ten feet. They should be planted considerably deeper than they grew in the nursery row or native thicket. This will enable them to stand the winds better and will afford better root protection in winter.

Before planting the land may be ridged by plowing it in narrow strips, setting the rows of trees between the ridges in the dead-furrows, pulverizing the soil well first. With this method of planting, which insures against loss from drouth, a quantity of black surface soil should be put around the roots of each tree in planting.

Plate VI—De Sota Plum Tree in Fruit. North Dakota Experiment Station.

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Keep the grass and weeds out and the soil moist by frequent cultivation. The trees will begin bearing in three or four years. A mulch of old straw spread on the ground after cultivation for the season has stopped will prevent root-killing in any open winters. It may also be necessary to bind tar paper about the trunk of each tree in the winter to protect from mice and rabbits. There is a very large list of varieties to select from that are a decided improvement over the ordinary wild type, especially in size. Some of these ripen their fruit too late for the far north. The De Soto, Forest Garden, Cheney, Rolf, Rollingstone, Wyant and Surprise is the list recommended by the Minnesota Horticultural Society for general cultivation.

APPLES.

To the average man fruit growing means apples. All over the country, on farms where no special effort is made to raise fruit, one will find apple trees growing. Because of the great adaptability of the apple to meet varying conditions this is true over large regions that a generation or two ago produced no apples. Generally speaking it has been found that the apple is introduced into regions of new conditions only as new varieties have been created to suit these conditions. Practically all of the apples grown in the eastern states today are of varieties that were created there, and the same condition is being found true in the northwest. Aside from the Russian apples that were created under conditions similar to our own, the only possible apples with us are those like the Lyman's Prolific, Wealthy, Patten's Greening, etc., apples that originated in the northwest.

While the development of new varieties is a thing apart from apple culture as generally understood, yet in a new country where apple growing is more or less uncertain because of the absence of thoroughly hardy varieties all who are interested in the development of the apple industry will be planting apple seeds from time to time. In ten years most of the trees thus produced will be bearing fruit. There were exhibited at Minneapolis last fall over one hundred seedling apples, many of them of high quality, all grown from apple seeds planted ten years ago.

At the same time, it is possible to accomplish something with the varieties in existence. Crabs and hybrids of the following varieties have been found suitable for growing in the northwest: Virginia, Whitney, Early Strawberry, Minnesota, Gideon No. 6, Florence and Lyman's Prolific.

Among apples suited for the same region are the Duchess, Hibernal, Charlamoff, Patten's Greening, Wealthy and Malinda.

Apples in this region seem to suceed better if the trees are headed very low, those heading right at the ground after the original tree had killed back often proving the most profitable trees. Where the soil will admit it, it is advisable to plant the trees from six inches

to a foot deeper than they grew in the nursery. Trees thus planted naturally grow a little slower and ripen their wood better, thus possibly reducing the danger of blight and winter killing, and at the same time they are less affected by drouth.

Ordinary varieties may be planted about twelve by sixteen feet apart, or if they have good shelter and rich soil, sixteen by twenty feet. It is not wise to try and grow apples without a good shelter belt on the south and west. This may be planted at the time the trees are set. It is a poor plan to buy large trees. They cost more and are worth less for the planter. It is better to buy two-year-old trees or even root grafts. When one does not feel like investing much money in apple trees, he can buy root grafts of the best varieties for three or four cents each that will make him as good trees in eight or ten years as he would obtain through planting trees of the regular size. Root grafts should be planted deeply, leaving a single bud above the ground. The situation may be still further improved by planting them in a broad trench made with a plow

Clean cultivation for apple orchards is undoubtedly the best, especially in a dry country. In very wet seasons a bushel of oats to the acre may be sowed upon the land late in July and harrowed in. These will help the trees to ripen their wood and will afford a protection in winter. They will not greatly interfere with cultivation the following spring. The apple blight must be guarded against, and when twigs or branches turn brown and die, usually in June, they must be cut off and burned.

It is found best not to trim apple trees much in regions like our own, but rather to let the head grow dense and compact to protect the trunk and larger limbs. The line of successful apple culture has moved toward the northwest so rapidly during the past twenty-five years that North Dakota also has something more than a reasonable hope for future success.

CURRANTS AND GOOSEBERRIES.

These are already succesfully grown more or less in most sections of the state, yet there are thousands of homes where the cultivation of even these valuable and easily grown fruits is not attempted. They thrive best in deep, moist soil. Given that and clean cultivation at the same time, allowing about eight canes to grow to the hill, cutting out the canes four years old and allowing only enough new ones to grow each year to take their place, and any one can grow these fruits in abundance.

Set the plants four by eight feet apart, and see that the grass does not get a foothold among the plants. They will stand a richer soil than most fruits, and stable manure forked into the soil close to the plants will increase the yield. If too many canes are allowed to grow in a hill, the fruit is small though the seeds are sure to be all there.

Plate VII—Picking Strawberries. North Dakota Experiment Station.

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The London Market is the best currant we have tried. The North Star, Red Dutch, Victoria, White Grape, Long Bunch, Holland, Pomona and Red Cross are all standard sorts. The Downing Champion and Houghton are the leading gooseberries.

RASPBERRIES.

Our success with raspberries has not been encouraging, though some have met with considerable success. With a better drained soil we think we could do better, but unless one is prepared to put considerable work upon his raspberry plantation, such as covering the plants in winter, keeping the suckers cut out as fast as they appear, etc., he had better confine himself to the other fruits.

This is not saying that with a good location and some time at his disposal a man might not be well repaid in his efforts to grow raspberries. There is no particular secret in their cultivation, at least if there is we haven't found it here. Set the plants four by eight feet apart, far enough to make cultivation easy. Allow six new canes to grow in each hill each season, cutting out all the rest. Remove the old canes in the fall, those that have borne fruit, so the new ones may be protected easier.

For protection bend them all to the north, throwing dirt on the tops to hold them down. After that plow a furrow on either side of each row, throwing the soil over the plants. If covered with straw they are liable to injury from mice. Lift the canes in the spring as soon as the weather is settled.

About the only varieties that have made much of a showing with us are the Cardinal, Colorado, Iron Clad and Loudon.

STRAWBERRIES.

Since our windbreaks have become established we have not experienced much difficulty in producing a good crop of strawberries each year. Last season there was no rain to speak of till after the fruit was ripe and yet the yield was very good.

The strawberry requires a well drained but moist soil. Avoid land that is very weedy, especially that containing foxtail and quack grass. Set the plants in early spring, planting them firmly with the roots spread out and extending straight down, and the crown just at the surface of the ground. Give them plenty of room to make cultivation easy and to allow each plant a good share of moisture. We set our plants two by four feet apart. If the soil is rather dry or weedy keep all of the runners cut off for the first season and make the cultivation very thorough.

If the soil conditions are good about three runners may be allowed for each plant, training them along the row so they will not interfere with cultivation. In the fall after the ground begins freezing cover with three inches of straw that is free from seeds of any kind. Take it from the side of the straw pile opposite from where the

machine stood. In the spring, when the straw is dry on top but still somewhat moist at the bottom, it may be burned off. If done at the right time enough will remain to spread about the plants as a mulch to retain the moisture and to keep the berries clean. After the first crop has been harvested the bed must be put in shape for the following year's crop. This is done by thorough cultivation for the remainder of the season, and the removal of runners as they appear.

It must be remembered that the fruit for any given season is all provided for and made ready the previous season. Unless the plants are kept thrifty and vigorous they will not find it possible to prepare for much of a fruit crop. In July and August the soil will become hard and baked unless constantly stirred. It is just at this time, however, that the plants should be doing their best work for the future and must not be neglected. If the bed is well tilled after the first crop, removing most of the old plants and encouraging the young ones, the second crop will be as large as the first one. By continuing this same method we have grown three good crops in succession on the same land, and last season one old bed was put into shape to see what the fourth crop will amount to. It is generally advised, however, to grow but two crops and then plow up the bed.

VARIETIES.

Out of the thirty-four varieties in the trial bed last season the following gave the highest yields, coming in the order named: Warfield, Tennessee Prolific, Emperor, Senator Dunlap, Sample, Wm. Belt, Beder Wood, Drouth King and New York. Of these the Warfield and Sample are not self-fertilizing and will need to be planted in alternate rows with some of the other varieties.

Considering vigor, hardiness and quality, the Senator Dunlap made perhaps the best showing. Twenty-four plants set in 1902 gave twenty-four and one-half quarts in 1903.

The Wm. Belt is another excellent berry and very large. We raised single specimens measuring seven inches in circumference, twelve of them filling a quart box. In all the tests made the plants were not watered. While the price for strawberries in North Dakota is very high, still we would not advise growing on a large scale till one is able to grow them successfully in a small way. To be successful one year with another it will be necessary to have a well sheltered location. With a good location and a thorough knowledge of the business, a profit of from $200 to $500 per acre should be obtained. The late varieties will ordinarily pay the best, as everything is out of the market by the time they are ready, and 15 to 18 cents wholesale can easily be obtained. Whether the proposition from a financial side is an enticing one or not, there are few people so situated that they may not have an abundance of this excellent fruit for home use.

C. B. WALDRON.

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